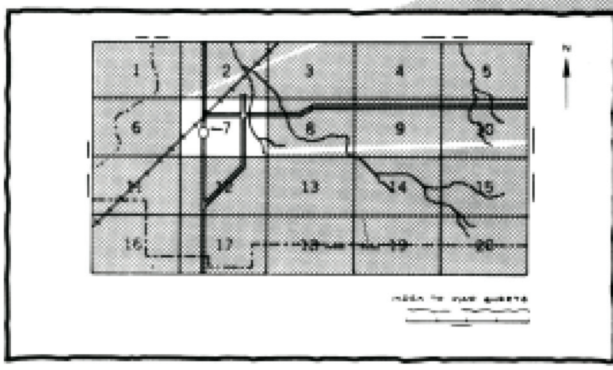
Soil Survey of

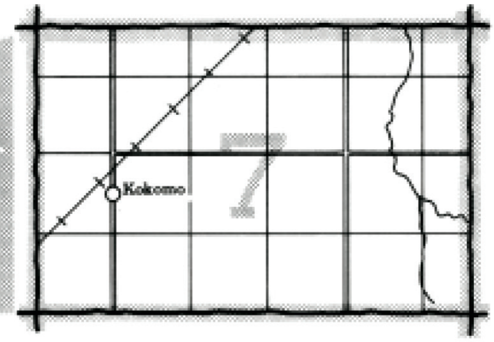
Lyon County, Kansas

United States Department of Agriculture
Soil Conservation Service
in cooperation with
Kansas Agricultural Experiment Station

HOW TO USE

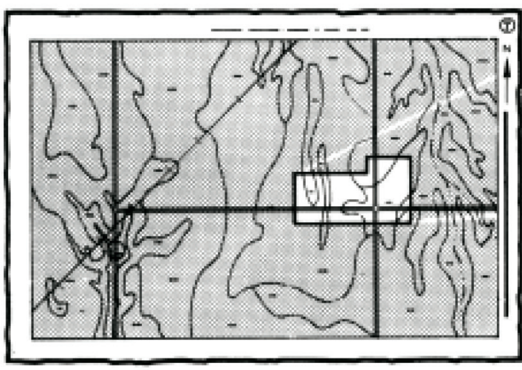
1. Locate your area of interest on the "Index to Map Sheets"

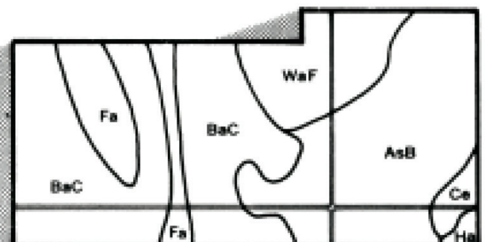




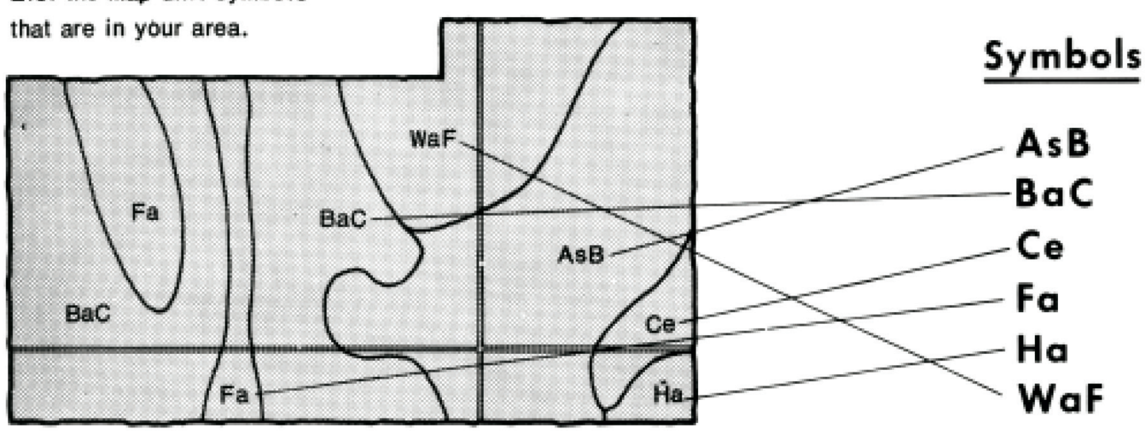
2. Note the number of the map sheet and turn to that sheet.

3. Locate your area of interest on the map sheet.



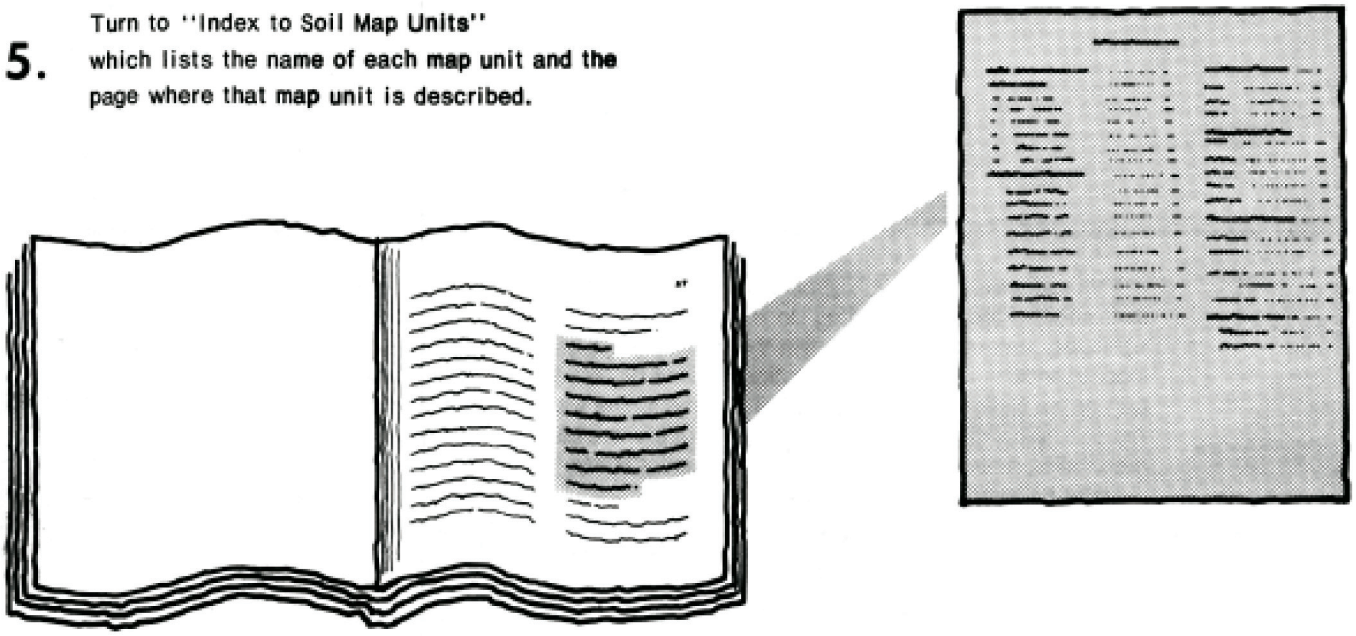


4. List the map unit symbols that are in your area.

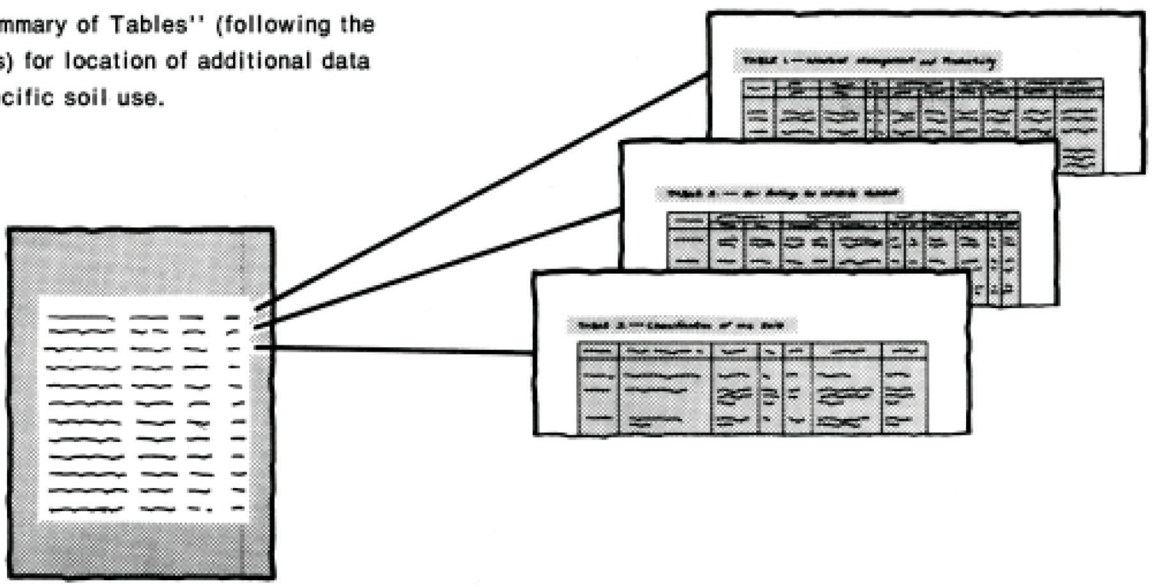


THIS SOIL SURVEY

5. Turn to "Index to Soil Map Units" which lists the name of each map unit and the page where that map unit is described.



6. See "Summary of Tables" (following the Contents) for location of additional data on a specific soil use.



7. Consult "Contents" for parts of the publication that will meet your specific needs. This survey contains useful information for farmers or ranchers, foresters or agronomists; for planners, community decision makers, engineers, developers, builders, or homebuyers; for conservationists, recreationists, teachers, or students; to specialists in wildlife management, waste disposal, or pollution control.

This is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and agencies of the States, usually the Agricultural Experiment Stations. In some surveys, other Federal and local agencies also contribute. The Soil Conservation Service has leadership for the Federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, or age.

Major fieldwork for this soil survey was completed in the period 1967-76. Soil names and descriptions were approved in 1977. Unless otherwise indicated, statements in the publication refer to conditions in the survey area in 1976. This survey was made cooperatively by the Soil Conservation Service and the Kansas Agricultural Experiment Station. It is part of the technical assistance furnished to the Lyon County Conservation District.

Soil maps in this survey may be copied without permission, but any enlargement of these maps can cause misunderstanding of the detail of mapping and result in erroneous interpretations. Enlarged maps do not show small areas of contrasting soils that could have been shown at a larger mapping scale.

Cover: Grain sorghum on Kenoma silt loam. The crop was planted on the contour and parallel with terraces that empty water into the grassed waterway.

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Issued May 1981

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Foreword

The Soil Survey of Lyon County, Kansas, contains much information useful in any land-planning program. Of prime importance are the predictions of soil behavior for selected land uses. Also highlighted are limitations or hazards to land uses that are inherent in the soil, improvements needed to overcome these limitations, and the impact that selected land uses will have on the environment.

This soil survey has been prepared for many different users. Farmers, ranchers, foresters, and agronomists can use it to determine the potential of the soil and the management practices required for food and fiber production. Planners, community officials, engineers, developers, builders, and homebuyers can use it to plan land use, select sites for construction, develop soil resources, or identify any special practices that may be needed to insure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the soil survey to help them understand, protect, and enhance the environment.

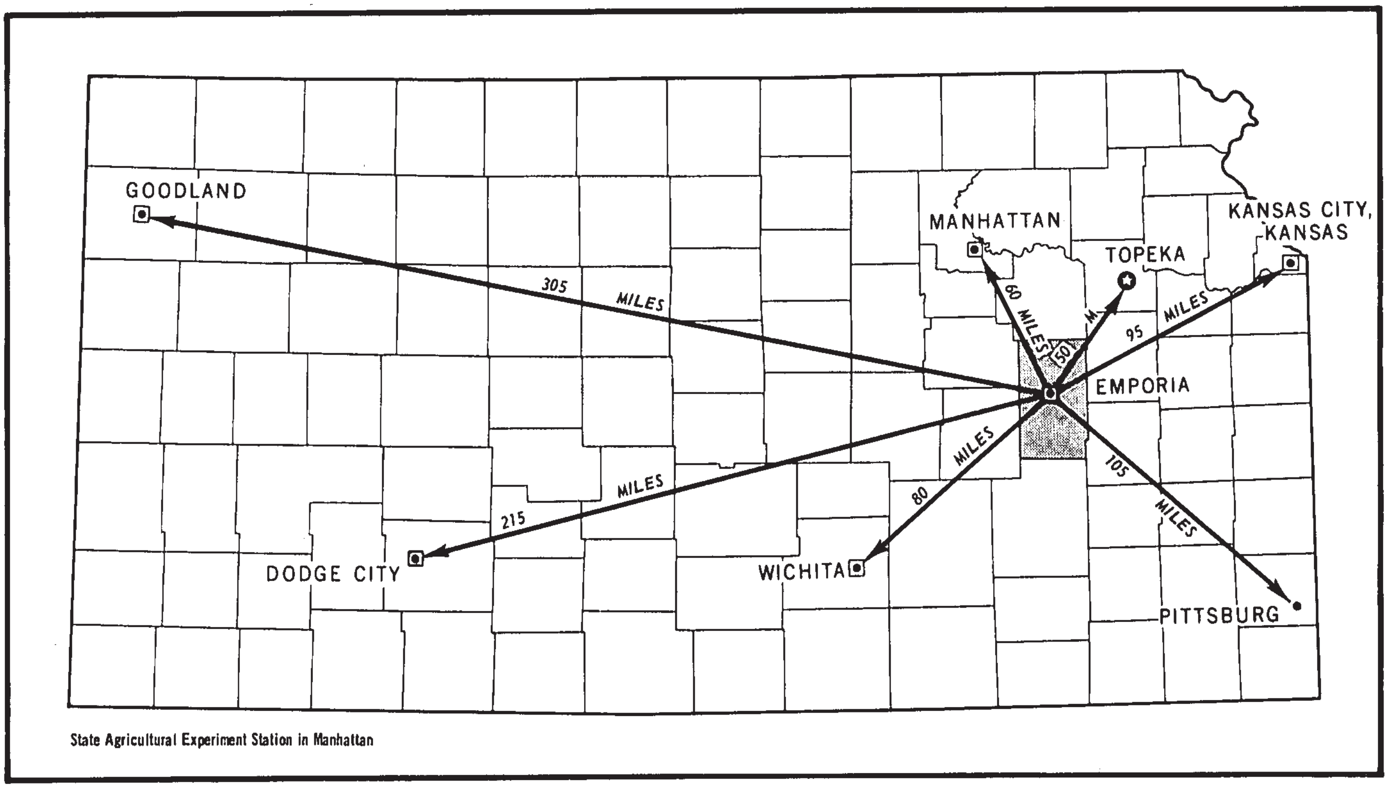
Great differences in soil properties can occur even within short distances. Soils may be seasonally wet or subject to flooding. They may be shallow to bedrock. They may be too unstable to be used as a foundation for buildings or roads. Very clayey or wet soils are poorly suited to septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map; the location of each kind of soil is shown on detailed soil maps. Each kind of soil in the survey area is described, and much information is given about each soil for specific uses. Additional information or assistance in using this publication can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

This soil survey can be useful in the conservation, development, and productive use of soil, water, and other resources.

Robert K. Griffin

Robert K. Griffin
State Conservationist
Soil Conservation Service



Location of Lyon County in Kansas.

Soil Survey of Lyon County, Kansas

By James T. Neill, Soil Conservation Service

with the assistance of
Elbert L. Bell, soil scientist
Soil Conservation Service

United States Department of Agriculture
Soil Conservation Service
in cooperation with
Kansas Agricultural Experiment Station

Lyon County is in east-central Kansas. The county has a total area of 852 square miles, or 545,280 acres. The population was 34,279 in 1977. In that year Emporia, the county seat, had a population of 24,905.

The western three-fourths of Lyon County is in the Bluestem Hills Resource Area. The rest is in the Cherokee Prairies Resource Area. The Bluestem Hills, commonly called the Flint Hills, have deeply entrenched drainageways. The soils are generally deep or moderately deep, are nearly level to moderately steep, and have a silty or clayey subsoil. In the Cherokee Hills the soils are generally deep, are nearly level to moderately sloping, and have a silty or clayey subsoil. Elevation ranges from 1,060 to 1,530 feet above sea level.

Most of Lyon County is drained by four permanent flowing streams, the Cottonwood, Neosho, Marais des Cygnes, and Verdigris Rivers. These streams flow in a southeasterly direction.

Lyon County has a continental climate. Summers are hot, and winters are cold. Mean annual temperature is 45 to 65 degrees F. Annual precipitation ranges from 25 to 45 inches.

The main enterprises in the county are farming and ranching. Grain sorghum, wheat, soybeans, and corn are the main crops. Industry, especially cattle feedlots and meat packing plants, provides many jobs in the county.

Mineral resources of Lyon County are oil, crushed limestone, shale, sand, and chert gravel.

Climate

By L. Dean Bark, climatologist, Kansas Agricultural Experiment Station, Manhattan, Kansas.

The climate of Lyon County is the continental type expected in the interior of a large land mass in the middle latitudes. It is characterized by large daily and annual variations in temperature. Winters are cold because of frequent outbreaks of air from the Polar region. Winter conditions prevail from December to February. The warm temperatures of summer last for about 6 months. They provide a long growing season for crops. The transitional seasons of spring and fall are short.

Lyon County is in the path of a fairly dependable current of moisture-laden air from the Gulf of Mexico. Precipitation is heaviest late in spring and early in summer. A good part of it falls during late evening or nighttime thunderstorms. The amount of precipitation is generally adequate, but the distribution is frequently poor. Dry periods of several weeks duration are not uncommon during the growing season. Excessive precipitation often delays planting and harvest.

Table 1 gives data on temperature and precipitation for the survey area, as recorded at Emporia for the period 1951 to 1970. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter the average temperature is 32 degrees F, and the average daily minimum temperature is 21 degrees. The lowest temperature on record, which occurred at Emporia on February 13, 1905, is -23 degrees. In summer the average temperature is 77 degrees, and the average daily maximum temperature is 88 degrees. The highest recorded temperature, which occurred on July 15, 1934, is 116 degrees.

Of the total annual precipitation, 25.30 inches, or 73 percent, usually falls in April through September, which includes the growing season for most crops. In 2 years out of 10, the rainfall in April through September is less than 16.05 inches. The heaviest 1-day rainfall during the period of record was 6.11 inches at Emporia on June 4, 1965.

Average seasonal snowfall is 15.0 inches. The greatest snow depth at any one time during the period of record was 14 inches. On the average, 20 days have at least 1 inch of snow on the ground, but the number of such days varies greatly from year to year.

The percentage of possible sunshine is 75 in summer and 55 in winter. The prevailing wind is from the south. Average windspeed is highest, 13 miles per hour, in March and April.

Tornadoes and severe thunderstorms occur occasionally. These storms are usually local in extent and of short duration so that the risk of damage is small. Hail occurs during the warmer part of the year but is infrequent and of local nature. Crop damage by hail is less in this part of the state than in western Kansas.

How this survey was made

Soil scientists made this survey to learn what kinds of soil are in the survey area, where they are, and how they can be used. The soil scientists went into the area knowing they likely would locate many soils they already knew something about and perhaps identify some they had never seen before. They observed the steepness, length, and shape of slopes; the size of streams and the general pattern of drainage; the kinds of native plants or crops; the kinds of rock; and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material, which has been changed very little by leaching or by the action of plant roots.

The soil scientists recorded the characteristics of the profiles they studied, and they compared those profiles with others in counties nearby and in places more distant. Thus, through correlation, they classified and named the soils according to nationwide, uniform procedures.

After a guide for classifying and naming the soils was worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show woodlands, buildings, field borders, roads, and other details that help in drawing boundaries accurately. The soil map at the back of this publication was prepared from aerial photographs.

The areas shown on a soil map are called soil map units. Some map units are made up of one kind of soil, others are made up of two or more kinds of soil, and a few have little or no soil material at all. Map units are discussed in the sections "General soil map for broad land use planning" and "Soil maps for detailed planning."

While a soil survey is in progress, samples of soils are taken as needed for laboratory measurements and for engineering tests. The soils are field tested, and interpretations of their behavior are modified as necessary during the course of the survey. New interpretations are added to meet local needs, mainly through field observations of different kinds of soil in different uses under different levels of management. Also, data are assembled from other sources, such as test results, records, field experience, and information available from state and local specialists. For example, data on crop yields under defined practices are assembled from farm records and from field or plot experiments on the same kinds of soil.

But only part of a soil survey is done when the soils have been named, described, interpreted, and delineated on aerial photographs and when the laboratory data and other data have been assembled. The mass of detailed information then needs to be organized so that it is readily available to different groups of users, among them farmers, managers of rangeland and woodland, engineers, planners, developers and builders, homebuyers, and those seeking recreation.

General soil map for broad land use planning

The general soil map at the back of this publication shows, in color, five associations that have a distinct pattern of soils and of relief and drainage. Each association is a unique natural landscape. Typically, an association consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up an association can occur in other associations but in a different pattern.

The general soil map provides a broad perspective of the soils and landscapes in the survey area. It provides a basis for comparing the potential of large areas for general kinds of land use. Areas that are, for the most part, suited to certain kinds of farming or to other land uses can be identified on the map. Likewise, areas of soils having properties that are distinctly unfavorable for certain land uses can be located.

Because of its small scale, the map does not show the kind of soil at a specific site. Thus, it is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The kinds of soil in any one map unit differ from place to place in slope, depth, stoniness, drainage, or other characteristics that affect their management.

1. Chase-Osage association

Deep, nearly level, moderately well drained and poorly drained soils that have a dominantly silty clay subsoil; on flood plains and low terraces

This association is on terraces and flood plains along rivers and larger creeks in the county. Meandering stream channels and oxbow lakes are common features. Poorly drained areas are adjacent to the uplands.

This association makes up about 11 percent of the county. It is about 37 percent Chase soils, 32 percent Osage soils, and 31 percent soils of minor extent (fig. 1).

The deep, moderately well drained Chase soils formed in clayey alluvium on occasionally flooded low terraces. Typically the surface layer is dark gray silty clay loam about 17 inches thick. The subsoil is about 29 inches thick. The upper part is very dark gray, firm silty clay loam, and the lower part is dark gray, very firm silty clay. The underlying material to a depth of about 60 inches is gray silty clay loam. In some years a seasonal perched water table is within the subsoil.

The deep, poorly drained Osage soils formed in clayey alluvium on frequently flooded flood plains. Typically the surface layer is dark gray silty clay about 13 inches thick. The extremely firm silty clay subsoil extends to a depth of about 60 inches. The upper part is dark gray, and the lower part is gray. In most years a seasonal perched water table is within the surface layer.

The minor soils of this association are the frequently flooded, moderately well drained Ivan soils on flood plains and the rarely flooded, well drained Reading soils on stream terraces.

Most areas of this association are cultivated. A few are range and woodland. The soils are suited to corn, grain sorghum, small grain, and soybeans and to grasses and legumes for hay and pasture. Fertility is medium to high. Flooding and wetness limit the choice of crops on some soils. The main concerns of management are improving surface drainage and maintaining the organic matter content and tilth of the soils.

This association has good potential for cultivated crops, range, and openland wildlife habitat. It has poor potential for building site development and sanitary facilities.

2. Clime-Sogn association

Moderately deep and shallow, moderately sloping to moderately steep, moderately well drained and somewhat excessively drained soils that have a silty clay subsoil or lack a subsoil; on uplands

This association is on ridgetops and side slopes that are dissected by drainageways. Limestone outcrops form rocky ledges near the ridgetops.

This association makes up about 9 percent of the county. It is about 55 percent Clime soils, 20 percent Sogn soils, and 25 percent soils of minor extent (fig. 2).

The moderately deep, moderately well drained Clime soils formed in material weathered from calcareous shale on side slopes and ridgetops. Typically the surface layer is dark grayish brown silty clay about 8 inches thick. The subsoil is grayish brown, very firm silty clay about 11 inches thick. The underlying material is light olive gray silty clay and contains shale fragments. Bedrock is at a depth of about 34 inches.

The shallow, somewhat excessively drained Sogn soils formed in material weathered from limestone. They are on ridgetops. Typically the surface layer is dark gray silty clay loam about 9 inches thick. The surface layer is underlain by bedrock.

The minor soils of this association are the well drained Labette soils on ridgetops, the moderately well drained Martin soils and somewhat poorly drained Zaar soils on foot slopes, and the moderately well drained Ivan soils on flood plains that are frequently flooded.

Most of this association is range. Cultivated areas are on the broader ridgetops and along the larger streams. The main concerns of management are proper stocking, conserving moisture, and maintaining the range in good condition. Ponds are the main source of water for livestock.

This association has fair potential for range and rangeland wildlife habitat. It has poor potential for cultivated crops, building site development, and sanitary facilities.

3. Kenoma-Martin-Elmont association

Deep, gently sloping and moderately sloping, moderately well drained and well drained soils that have a silty clay or silty clay loam subsoil; on uplands

This association is on ridgetops and side slopes that are dissected by intermittent drainageways.

This association makes up about 54 percent of the county. It is about 30 percent Kenoma soils, 15 percent Martin soils, 10 percent Elmont soils, and 45 percent soils of minor extent.

The deep, moderately well drained Kenoma soils formed in material weathered from old clayey alluvium on ridgetops and side slopes. Typically the surface layer is grayish brown silt loam or silty clay loam about 6 to 10 inches thick. The subsoil is very firm silty clay about 48 inches thick. The upper part is grayish brown, and the lower part is brown, dark grayish brown, and yellowish brown with mottles. The underlying material to a depth of about 60 inches is yellowish brown silty clay.

The deep, moderately well drained Martin soils formed in material weathered from shale on foot slopes. Typically the surface layer is dark gray silty clay loam or silty clay about 5 to 12 inches thick. The subsoil extends to a depth of about 60 inches. The upper part is dark gray, firm silty clay; the middle part is very dark grayish brown and grayish brown, very firm silty clay; and the lower part is light olive brown, mottled, extremely firm silty clay.

The deep, well drained Elmont soils formed in material weathered from shale on foot slopes. Typically the surface layer is dark grayish brown silt loam or silty clay loam about 6 to 12 inches thick. The subsoil is about 36 inches thick. The upper part is brown, friable silty clay loam. The middle part is brown, mottled, firm silty clay loam. The lower part is yellowish brown, mottled, very firm silty clay loam. Bedrock is at a depth of about 48 inches.

The minor soils of this association are the moderately deep, well drained Bates soils on side slopes; the mod-

erately deep, moderately well drained Clime soils on side slopes; the moderately deep, moderately well drained Eram soils on side slopes; the deep, moderately well drained Ivan soils along upland drainageways that frequently flood; and the moderately deep, well drained Labette soils on ridgetops.

About two-thirds of this association is cultivated. The rest is mostly range. Grain sorghum, wheat, soybeans, and grass and legumes for hay and pasture are the main crops. Water erosion is a hazard on the gently sloping and moderately sloping areas. Controlling erosion and maintaining soil tilth and fertility are the main concerns of management.

This association has good potential for cultivated crops, range, and openland wildlife habitat. It has poor potential for building site development and sanitary facilities.

4. Kenoma-Ladysmith association

Deep, nearly level and gently sloping, moderately well drained soils that have a silty clay subsoil; on uplands

This association is on broad ridgetops and gently sloping side slopes.

This association makes up about 16 percent of the county. It is about 50 percent Kenoma soils, 25 percent Ladysmith soils, and 25 percent soils of minor extent.

The deep, moderately well drained Kenoma soils formed in material weathered from old clayey alluvium on side slopes. Typically the surface layer is grayish brown silt loam or silty clay loam about 10 inches thick. The subsoil is very firm silty clay about 48 inches thick. The upper part is grayish brown, and the lower part is brown, dark grayish brown, and yellowish brown with mottles. The underlying material to a depth of about 60 inches is yellowish brown silty clay.

The deep, moderately well drained Ladysmith soils formed in material weathered from old alluvium or eolian sediments on broad ridgetops. Typically the surface layer is dark gray silty clay loam about 8 inches thick. The subsoil is about 29 inches thick. The upper part is dark gray, very firm silty clay, and the lower part is dark grayish brown, mottled, very firm silty clay. The underlying material to a depth of about 60 inches is light brownish gray and light gray silty clay loam.

The minor soils of this association are the deep, well drained Elmont soils on foot slopes; the moderately deep, moderately well drained Eram soils on side slopes; and the moderately deep, well drained Labette soils on side slopes.

About two-thirds of this association is cultivated. The rest is mostly range. Grain sorghum, wheat, soybeans, and grasses and legumes for hay and pasture are the main crops. Water erosion is a hazard on gently sloping areas. Controlling erosion and maintaining soil tilth and fertility are the main concerns of management.

This association has good potential for cultivated crops, range, and openland wildlife habitat. It has poor potential for building site development and sanitary facilities.

5. Tully-Florence association

Deep, gently sloping and strongly sloping, well drained soils that have a dominantly silty clay or cherty clay subsoil; on uplands

This association is on narrow ridgetops and side slopes dissected by narrow intermittent drainageways.

This association makes up about 10 percent of the county. It is about 20 percent Tully soils, 15 percent Florence soils, and 65 percent soils of minor extent.

The deep, well drained Tully soils formed in material weathered from limestone and interbedded shale on foot slopes. Typically the surface layer is dark grayish brown silty clay loam about 10 inches thick. The subsoil extends to a depth of 60 inches. The upper part is dark grayish brown, firm silty clay loam; the middle part is dark grayish brown and grayish brown, firm and very firm silty clay; and the lower part is brown, firm silty clay.

The deep, well drained Florence soils formed in material weathered from cherty limestone on side slopes. Typically the surface layer is dark grayish brown cherty silt loam about 13 inches thick. The subsoil is about 33 inches thick. The upper part is dark brown, very firm cherty silty clay loam, and the lower part is reddish brown, extremely firm cherty clay. Bedrock is at a depth of about 46 inches.

The minor soils of this association are the moderately deep, moderately well drained Clime soils on side slopes; the deep, moderately well drained Ivan soils along upland drainageways that frequently flood; the deep, moderately well drained Kenoma soils on ridgetops; the moderately deep, well drained Labette soils on ridgetops; and the shallow, somewhat excessively drained Sogn soils on side slopes.

Most of this association is range. The main concerns of management are proper stocking, conserving moisture, and maintaining the range in good condition. Ponds are the main source of water for livestock.

This association has good potential for range and fair potential for rangeland wildlife habitat. It has poor potential for cultivated crops, building site development, and sanitary facilties.

Soil maps for detailed planning

The map units shown on the detailed soil maps at the back of this publication represent the kinds of soil in the survey area. They are described in this section. The descriptions together with the soil maps can be useful in determining the potential of a soil and in managing it for food and fiber production; in planning land use and de-

veloping soil resources; and in enhancing, protecting, and preserving the environment. More information for each map unit, or soil, is given in the section "Use and management of the soils."

Preceding the name of each map unit is the symbol that identifies the soil on the detailed soil maps. Each soil description includes general facts about the soil and a brief description of the soil profile. In each description, the principal hazards and limitations are indicated, and the management concerns and practices needed are discussed.

The map units on the detailed soil maps represent an area on the landscape made up mostly of the soil or soils for which the unit is named. Most of the delineations shown on the detailed soil map are phases of soil series.

Soils that have a similar profile make up a *soil series*. Except for allowable differences in texture of the surface layer or of the underlying substratum, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement in the profile. A soil series commonly is named for a town or geographic feature near the place where a soil of that series was first observed and mapped. The Reading series, for example, was named for the town of Reading in Lyon County.

Soils of one series can differ in texture of the surface layer or in the underlying substratum and in slope, erosion, stoniness, salinity, wetness, or other characteristics that affect their use. On the basis of such differences, a soil series is divided into phases. The name of a *soil phase* commonly indicates a feature that affects use or management. For example, Kenoma silty clay loam, 3 to 6 percent slopes, eroded, is one of several phases within the Kenoma series.

Some map units are made up of two or more dominant kinds of soil. Such map units are called soil complexes.

A *soil complex* consists of areas of two or more soils that are so intricately mixed or so small in size that they cannot be shown separately on the soil map. Each area includes some of each of the two or more dominant soils, and the pattern and proportion are somewhat similar in all areas. Clime-Sogn complex, 5 to 20 percent slopes is an example.

An *undifferentiated group* is made up of two or more soils that could be mapped individually but are mapped as one unit because there is little value in separating them. The pattern and proportion of the soils are not uniform. An area shown on the map has at least one of the dominant (named) soils or may have all of them. Eram and Bates soils, 6 to 15 percent slopes, is an undifferentiated group in this survey area.

Most map units include small, scattered areas of soils other than those that appear in the name of the map unit. Some of these soils have properties that differ substantially from those of the dominant soil or soils and thus could significantly affect use and management of the map unit. These soils are described in the description of each map unit. Some of the more unusual or strongly contrasting soils that are included are identified by a special symbol on the soil map.

The acreage and proportionate extent of each map unit are given in table 4, and additional information on properties, limitations, capabilities, and potentials for many soil uses is given for each kind of soil in other tables in this survey. (See "Summary of tables.") Many of the terms used in describing soils are defined in the Glossary.

Ba—Bates loam, 3 to 6 percent slopes. This moderately sloping, well drained soil is on side slopes. Individual areas are irregular in shape and range from 5 to 40 acres.

Typically the surface layer is dark grayish brown loam about 9 inches thick. The subsoil is about 25 inches thick. The upper part is brown, friable loam. The lower part is dark brown and yellowish brown, firm clay loam. Bedrock is at a depth of about 34 inches. In some places the surface layer is clay loam or fine sandy loam.

Included with this soil in mapping are small areas of Elmont and Vinland soils. The deep Elmont soils are on foot slopes. The shallow Vinland soils are on upper side slopes. Included soils make up 10 to 15 percent of the unit.

Permeability is moderate, and available water capacity is low. Surface runoff is medium. The organic matter content is moderate, and natural fertility is medium. The surface layer is friable and is easily tilled. The root zone is restricted by bedrock at about 34 inches.

About one-third the acreage is cultivated. The rest is mostly range. The potential is good for range and for openland, rangeland, and woodland wildlife habitat. It is fair for cultivated crops and for windbreak and environmental plantings. It is fair to poor for building site development and sanitary facilities.

This soil is moderately well suited to grain sorghum and wheat and to grasses and legumes for hay and pasture. Erosion is a hazard in cultivated areas. Minimum tillage, grassed waterways, terraces, and contour farming reduce soil loss and conserve moisture. Returning crop residue to the soil helps in maintaining the organic matter content and soil tilth.

This soil is well suited to range. Overgrazing reduces the vigor and growth of grasses. Proper stocking and rotation grazing are needed to keep the range in good condition.

This soil is moderately well suited to windbreak and environmental plantings. Selecting adapted species and preparing the site to control erosion and competing vegetation help in establishing plantings. Protection from livestock and fire is needed.

This soil is suitable for dwellings without basements. Depth to rock is a severe limitation for septic tank absorption fields. Depth to rock, the slope, and seepage

are moderate limitations for sewage lagoons. Sealing the lagoon reduces seepage. Onsite investigation is needed to locate deep soils in less sloping areas that are more suitable for sewage lagoons. Low strength is a moderate limitation for local roads and streets. Strengthening or replacing the base material reduces this limitation.

The capability subclass is IIIe.

Bb—Bates loam, 3 to 6 percent slopes, eroded. This moderately sloping, well drained soil is on side slopes. Individual areas are irregular in shape and range from 5 to 40 acres.

Erosion has removed most of the orginal surface layer. The present surface layer is dark grayish brown loam about 4 inches thick. The subsoil is about 25 inches thick. The upper part is brown, friable loam. The lower part is dark brown and yellowish brown, firm clay loam. Bedrock is at a depth of about 29 inches. In some places the surface layer is clay loam. In some places the depth to bedrock is less than 20 inches.

Included with this soil in mapping are small areas of Elmont and Vinland soils. The deep Elmont soils are on foot slopes. The shallow Vinland soils are on upper side slopes. Included soils make up 10 to 15 percent of the unit.

Permeability is moderate, and available water capacity is low. Surface runoff is medium. The organic matter content is moderately low. Natural fertility is low. The surface layer is friable and is easily tilled. The root zone is restricted by bedrock at about 29 inches.

About half the acreage is cultivated. The rest is mostly reseeded range. The potential is good for range and for openland, rangeland, and woodland wildlife habitat. It is fair for cultivated crops and for windbreak and environmental plantings. It is fair to poor for building site development and sanitary facilities.

This soil is moderately well suited to wheat and grain sorghum and to grasses and legumes for hay and pasture. Additional erosion is a hazard if this soil is cultivated. Minimum tillage, grassed waterways, terraces, and contour farming reduce soil loss and conserve moisture. Returning crop residue and other material to the soil improves fertility and helps in maintaining tilth.

This soil is suited to range. The major limitations in range management are related to the low forage production of abandoned cropland and to the hazard of erosion. Reseeding abandoned cropland with desirable mid and tall grasses improves forage production. An adequate plant cover and ground mulch are needed to reduce runoff, prevent excessive soil loss, and improve the moisture supplying capacity. Overgrazing reduces the protective cover and causes deterioration of the plant community. The more desirable grasses are replaced by less productive mid and short grasses and by weeds. Proper stocking, deferred grazing, and brush management are needed to keep the range in good condition.

This soil is moderately well suited to windbreak and environmental plantings. Selecting adapted species and preparing the site to control erosion and competing vegetation help in establishing plantings. Protection from livestock and fire is needed.

This soil is suitable for dwellings without basements. Depth to rock is a severe limitation for septic tank absorption fields. Depth to rock, seepage, and the slope are moderate limitations for sewage lagoons. Onsite investigation is needed to locate deep soils in less sloping areas that are more suitable for sewage lagoons. Sealing the lagoon reduces seepage. Low strength is a moderate limitation for local roads and streets. Strengthening or replacing the base material reduces this limitation.

The capability subclass is IVe.

Bc—Bates-Collinsville complex, 3 to 15 percent slopes. This map unit consists of moderately sloping to moderately steep, well drained soils on side slopes and ridgetops. It is 60 to 80 percent Bates soil and 20 to 40 percent Collinsville soil. The Bates soil is on convex side slopes and ridgetops, and the Collinsville soil is on the steeper side slopes. Areas of the two soils are so intricately mixed that it is not practical to map them separately. Individual areas are irregular in shape and range from 10 to 50 acres.

Typically the Bates soil has a surface layer of dark grayish brown loam about 8 inches thick. The subsoil is about 23 inches thick. The upper part is brown, friable loam. The lower part is dark brown and yellowish brown, firm clay loam. Bedrock is at a depth of about 31 inches.

Typically the Collinsville soil has a surface layer of dark grayish brown fine sandy loam about 7 inches thick. The underlying material is brown gravelly fine sandy loam that is about 4 inches thick and is 35 percent sandstone fragments. Bedrock is at a depth of about 11 inches. In some places the surface layer contains a few sandstone fragments.

Included with this unit in mapping are small areas of Elmont and Vinland soils. The deep Elmont soils are on foot slopes. The Vinland soils are shallow over shale. They are on lower side slopes. Included soils make up 10 to 20 percent of the unit.

Permeability is moderate in the Bates soil and moderately rapid in the Collinsville soil. The available water capacity is low in the Bates soil and very low in the Collinsville soil. Surface runoff is rapid. Root development is restricted by bedrock at about 31 inches in the Bates soil and 11 inches in the Collinsville soil.

Most of the acreage is range. The potential is good for range. It is fair for windbreak and environmental plantings and for openland, rangeland, and woodland wildlife habitat. It is poor for cultivated crops. It is fair to poor for building site development and sanitary facilities.

This unit is well suited to range. The major limitations in range management are related to the hazard of erosion. Overgrazing reduces the protective cover and

causes deterioration of the plant community. The more desirable grasses are replaced by less productive mid and short grasses and by weeds. An adequate plant cover and ground mulch are needed to reduce runoff, prevent excessive soil loss, and improve the moisture supplying capacity. Proper stocking, rotation grazing, and uniform distribution of grazing are needed to keep the range in good condition. Potential pond sites are numerous.

This unit is moderately well suited to windbreak and environmental plantings. Selecting adapted species and preparing the site to control erosion and competing vegetation help in establishing plantings. Protection from livestock and fire is needed.

The Bates soil is suitable for dwellings without basements. Depth to rock is a severe limitation in the Collinsville soil. Depth to rock in both soils is a severe limitation for septic tank absorption fields. Depth to rock, the seepage, and the slope are moderate limitations for sewage lagoons in the Bates soil and severe limitations in the Collinsville soil. Onsite investigation is needed to locate deep soils in less sloping areas that are more suitable for sewage lagoons. Sealing the lagoon reduces seepage. Low strength is a moderate limitation for local roads and streets in the Bates soil. Strengthening or replacing the base material reduces this limitation. Depth to rock is a severe limitation for local roads and streets in the Collinsville soil.

The capability subclass is VIs.

Ca—Chase silty clay loam. This nearly level, moderately well drained soil is on low stream terraces that are flooded occasionally. Individual areas are long and irregular in shape and range from 20 to 1,000 acres.

Typically the surface soil is dark gray silty clay loam about 17 inches thick. The subsoil is about 29 inches thick. The upper part is very dark gray, firm silty clay loam. The lower part is dark gray, very firm silty clay. The underlying material to a depth of about 60 inches is gray silty clay loam.

Included with this soil in mapping are small areas of Osage and Reading soils. The poorly drained Osage soils are on flood plains. The well drained Reading soils occupy higher parts of stream terraces. Included soils make up 10 to 15 percent of the unit.

Permeability is slow, and available water capacity is high. Surface runoff is slow. The organic matter content is moderate, and natural fertility is medium. The surface layer is friable and is easily tilled. A seasonal perched water table is within 1 to 3 feet of the surface in spring. The shrink-swell potential is high.

Most of the acreage is cultivated. The potential is good for cultivated crops, windbreak and environmental plantings, and range and for openland, rangeland, and woodland wildlife habitat. It is poor for building site development and sanitary facilities.

This soil is well suited to corn, wheat, and soybeans and to grasses and legumes for hay and pasture. Flooding and ponding sometimes delay spring planting. Field drainage ditches are needed in cultivated areas. Returning crop residue to the soil helps in maintaining the organic matter content and soil tilth.

This soil is well suited to range. Overgrazing reduces the vigor and growth of grasses. Proper stocking and rotation grazing are needed to keep the range in good condition.

This soil is well suited to windbreak and environmental plantings. Selecting adapted species and preparing the site to control competing vegetation help in establishing plantings.

The hazard of flooding is a severe limitation for dwellings, septic tank absorption fields, sewage lagoons, and local roads and streets. Dikes, levees, or other flood-control structures reduce this hazard.

The capability subclass is IIw.

Cb—Clime silty clay, 3 to 7 percent slopes. This moderately sloping, moderately well drained soil is on side slopes. Individual areas are irregular in shape and range from 5 to 100 acres.

Typically the surface layer is dark grayish brown, calcareous silty clay about 8 inches thick. The subsoil is grayish brown, calcareous, very firm silty clay about 11 inches thick. The underlying material is light olive gray silty clay about 15 inches thick. Bedrock is at a depth of about 34 inches. In some places limestone fragments are on the surface.

Included with this soil in mapping are small areas of the deep Martin soils on foot slopes. These soils make up 5 to 10 percent of the unit.

Permeability is slow, and available water capacity is low. Surface runoff is medium. The organic matter content is moderate, and natural fertility is medium. The surface layer is firm and is difficult to till. The soil is calcareous throughout. The root zone is restricted by bedrock at about 34 inches. The shrink-swell potential is moderate.

About two-thirds of the acreage is range. The rest is mostly cultivated. The potential is fair for cultivated crops, windbreak and environmental plantings, and range and for openland and rangeland wildlife habitat. It is poor for building site development and sanitary facilities.

This soil is moderately well suited to wheat and grain sorghum and to grasses and legumes for hay and pasture. Erosion is a hazard in cultivated areas. Minimum tillage, grassed waterways, terraces, and contour farming help to reduce soil loss and conserve moisture. Returning crop residue to the soil helps in maintaining organic matter content and soil tilth.

This soil is moderately well suited to range. Reseeding abandoned cropland with desirable mid and tall grasses improves forage production. Overgrazing reduces the

vigor and growth of grasses. Proper use and rotation grazing are needed to keep the range in good condition.

This soil is moderately well suited to windbreak and environmental plantings. Selecting adapted species and preparing the site to control erosion and competing vegetation help in establishing plantings. Protection from livestock and fire is needed.

The shrink-swell potential is a moderate limitation for dwellings without basements. Properly designed and reinforced foundations, foundation drains, and backfill of sand or gravel reduce the risk of structural damage. Depth to rock and slow permeability are severe limitations for septic tank absorption fields. Depth to rock and the slope are moderate limitations for sewage lagoons. Onsite investigation is needed to locate deep soils in less sloping areas that are more suitable for sewage lagoons. Low strength is a severe limitation for local roads and streets. Strengthening or replacing the base material reduces this limitation.

The capability subclass is IVe.

Cc—Clime silty clay, 3 to 7 percent slopes, eroded. This moderately sloping, moderately well drained soil is on side slopes. Individual areas are irregular in shape and range from 5 to 40 acres.

Erosion has removed most of the original surface layer. Typically the present surface layer is dark grayish brown silty clay about 5 inches thick. The subsoil is about 7 inches thick. It is grayish brown, very firm silty clay. The underlying material is light olive gray silty clay. Shale is at a depth of about 28 inches. In some places the soil is deeper over shale. In some places limestone fragments are on the surface.

Included with this soil in mapping are small areas of deep Martin soils on foot slopes. These soils make up about 5 to 10 percent of the unit.

Permeability is slow, and available water capacity is low. The surface layer is firm and is difficult to till. Surface runoff is medium. The soil is calcareous throughout. The organic matter content is moderately low, and natural fertility is low. The root zone is restricted by bedrock at about 28 inches. The shrink-swell potential is moderate.

About half the acreage is cultivated. The rest is mostly abandoned cropland. The potential is fair for range, windbreak and environmental plantings, and rangeland wildlife habitat. It is poor for cultivated crops, building site development, and sanitary facilities.

This soil is suited to range. The major limitations in range management are related to the low forage production of abandoned cropland and to the hazard of erosion. Reseeding abandoned cropland with desirable mid and tall grasses improves forage production. An adequate plant cover and ground mulch are needed to reduce runoff, prevent excessive soil loss, and improve the moisture supplying capacity. Overgrazing reduces the protective cover and causes deterioration of the plant community. The more desirable grasses are then replaced by less productive mid and short grasses and by weeds. Proper stocking, deferred grazing, and brush management are needed to keep the range in good condition.

This soil is moderately well suited to windbreak and environmental plantings. Selecting adapted species and preparing the site to control erosion and competing vegetation help in establishing plantings. Protection from livestock and fire is needed.

The shrink-swell potential is a moderate limitation for dwellings without basements. Properly designed and reinforced foundations, foundation drains, and backfill of sand or gravel reduce the risk of structural damage. Depth to rock and slow permeability are severe limitations for septic tank absorption fields. Depth to rock and the slope are moderate limitations for sewage lagoons. Onsite investigation is needed to locate deep soils in less sloping areas that are more suitable for sewage lagoons. Low strength is a severe limitation for local roads and streets. Strengthening or replacing the base material reduces this limitation.

The capability subclass is VIe.

Cd—Clime-Sogn complex, 5 to 20 percent slopes. This map unit consists of moderately sloping to moderately steep, moderately well drained and somewhat excessively drained soils on ridgetops and side slopes. It is 70 to 90 percent Clime soil and 10 to 30 percent Sogn soil. The Clime soil is on side slopes, and the Sogn soil is on convex ridgetops (fig. 3). Areas of these soils are so intricately mixed that it is not practical to map them separately. Individual areas are irregular in shape and range from 10 to 400 acres.

Typically the Clime soil has a surface layer of dark grayish brown silty clay about 8 inches thick. The subsoil is grayish brown, very firm silty clay about 11 inches thick. The underlying material, to a depth of 34 inches, is light olive gray silty clay. Bedrock is at a depth of about 34 inches. In some places limestone fragments are on the surface.

Typically the Sogn soil has a surface layer of dark gray silty clay loam that is about 9 inches thick and contains a few limestone fragments. Bedrock is at a depth of about 9 inches.

Included with this unit in mapping are small areas of Labette and Martin soils. The well drained Labette soils are on ridgetops. The deep Martin soils are on foot slopes. Included soils make up 10 to 20 percent of the unit.

Permeability is slow in the Clime soil and moderate in the Sogn soil. The available water capacity is low in the Clime soil and very low in the Sogn soil. Surface runoff is rapid. The Clime soil is calcareous throughout. Root development is restricted by bedrock at about 34 inches in the Clime soil and 9 inches in the Sogn soil. The shrink-swell potential is moderate in both soils.

Most of the acreage is range. The potential is fair for range, rangeland wildlife habitat, and windbreak and environmental plantings. It is poor for cultivated crops, building site development, and sanitary facilities.

This unit is best suited to range. The major limitations in range management are the hazards of erosion and droughtiness because of the low and very low available water capacity. An adequate plant cover and ground mulch are needed to reduce runoff, prevent excessive soil loss, and improve the available water capacity. Overgrazing reduces the vigor and growth of the grasses and causes deterioration of the plant community. The more desirable grasses are replaced by less productive mid and short grasses and by weeds. Proper stocking, rotation grazing, and uniform grazing distribution are needed to keep the range in good condition. Potential pond sites are numerous.

The Clime soil is moderately well suited to windbreak and environmental plantings. The Sogn soil is generally not suited. Selecting adapted species and preparing the site to control erosion and competing vegetation help in establishing the plantings. Protection from livestock and fire is needed.

Slope and the shrink-swell potential in the Clime soil are moderate limitations for dwellings without basements. Properly designed and reinforced foundations, foundation drains, and backfill of sand or gravel reduce the risk of structural damage caused by shrinking and swelling. Depth to rock in the Sogn soil is a severe limitation for dwellings. Depth to rock in both soils and slow permeability in the Clime soil are severe limitations for septic tank absorption fields. Slope in the Clime soil and depth to rock in the Sogn soil are severe limitations for sewage lagoons. Onsite investigation is needed to locate deep soils in less sloping areas that are more suitable for sewage lagoons. Low strength is a severe limitation for local roads and streets in the Clime soil. Strengthening or replacing the base material reduces this limitation. Depth to rock in the Sogn soil is a severe limitation for local roads and streets.

The capability subclass is VIe.

Ea—Elmont silt loam, 1 to 4 percent slopes. This gently sloping, well drained soil is on foot slopes. Individual areas of this unit are irregular in shape and range from 10 to 50 acres.

Typically the surface soil is dark grayish brown silt loam about 12 inches thick. The subsoil is about 36 inches thick. The upper part is brown, friable silty clay loam. The middle part is brown, mottled, firm silty clay loam. The lower part is yellowish brown, mottled, very firm silty clay loam. Bedrock is at a depth of about 48 inches. In some places the surface soil is silty clay loam.

Included with this soil in mapping are small areas of Bates and Kenoma soils. The moderately deep Bates soils are on side slopes. The deep, moderately well drained Kenoma soils are on ridgetops. Included soils make up about 10 to 15 percent of the unit.

Permeability is moderately slow, and available water capacity is high. Surface runoff is medium. The organic matter content is moderate, and natural fertility is medium. The surface layer is friable and is easily tilled. The shrink-swell potential is moderate.

About half the acreage is cultivated. The rest is mostly range. The potential is good for cultivated crops, windbreak and environmental plantings, range, and for openland and woodland wildlife habitat. It is fair for building site development and sanitary facilities.

This soil is well suited to corn, wheat, and soybeans and to grasses and legumes for hay and pasture. Erosion is a hazard in cultivated areas. Minimum tillage, grassed waterways, terraces, and contour farming reduce soil loss. Returning crop residue to the soil helps in maintaining organic matter content and soil tilth.

This soil is well suited to range. Overgrazing reduces the vigor and growth of grasses. Proper stocking and rotation grazing are needed to keep the range in good condition.

This soil is well suited to windbreak and environmental plantings. Selecting adapted species and preparing the site to control erosion and competing vegetation help in establishing plantings. Protection from livestock and fire is needed.

The shrink-swell potential is a moderate limitation for dwellings. Properly designed and reinforced foundations, foundation drains, and backfill of sand or gravel reduce the risk of structural damage. Moderately slow permeability is a severe limitation for septic tank absorption fields. Increasing the size of the absorption field improves the functioning of septic tank systems. Slope is a moderate limitation for sewage lagoons. Onsite investigation is needed to locate the deeper soils in less sloping areas that are more suitable for sewage lagoons. Low strength is a severe limitation for local roads and streets. Strengthening or replacing the base material reduces this limitation.

The capability subclass is IIe.

Eb—Elmont silt loam, 4 to 7 percent slopes. This moderately sloping, well drained soil is on foot slopes. Individual areas are long and irregular and range from 10 to 100 acres.

Typically the surface soil is dark grayish brown silt loam about 12 inches thick. The subsoil is about 36 inches thick. The upper part is brown, friable silty clay loam. The middle part is brown, mottled, firm silty clay loam. The lower part is yellowish brown, mottled, very firm silty clay loam. Bedrock is at a depth of about 48 inches. In some places the surface soil is silty clay loam.

Included with this soil in mapping are small areas of Eram and Kenoma soils. The moderately deep Eram soils are on side slopes. The deep moderately well

drained Kenoma soils are on ridgetops. Included soils make up about 10 to 15 percent of the unit.

Permeability is moderately slow, and available water capacity is high. Surface runoff is medium. The organic matter content is moderate, and natural fertility is medium. The surface layer is friable and is easily tilled. The shrink-swell potential is moderate.

About half the acreage is cultivated. The rest is mostly range. The potential is good for cultivated crops, windbreak and environmental plantings, and range. It is fair for openland wildlife habitat, building site development, and sanitary facilities.

This soil is well suited to corn, wheat, and soybeans and to grasses and legumes for hay and pasture. Erosion is a hazard in cultivated areas. Minimum tillage, grassed waterways, terraces, and contour farming reduce soil loss. Returning crop residue to the soil helps in maintaining organic matter content and soil tilth.

This soil is well suited to range. Overgrazing reduces the vigor and growth of grasses. Proper stocking and rotation grazing are needed to keep the range in good condition.

This soil is well suited to windbreak and environmental plantings. Selecting adapted species and preparing the site to control erosion and competing vegetation help in establishing plantings. Protection from livestock and fire is needed.

The shrink-swell potential is a moderate limitation for dwellings. Properly designed and reinforced foundations, foundation drains, and backfill of sand or gravel reduce the risk of structural damage. Moderately slow permeability is a severe limitation for septic tank absorption fields. Increasing the size of the absorption field improves the functioning of septic tank systems. Slope is a moderate limitation for sewage lagoons. Onsite investigation is needed to locate deeper soils in less sloping areas that are more suitable for sewage lagoons. Low strength is a severe limitation for local roads and streets. Strengthening or replacing the base material reduces this limitation.

The capability subclass is IIIe.

Ec—Elmont silty clay loam, 3 to 7 percent slopes, eroded. This moderately sloping, well drained soil is on foot slopes. Individual areas are long and irregular in shape and range from 10 to 50 acres.

Erosion has removed most of the original surface layer. Typically the present surface layer is dark grayish brown silty clay loam about 6 inches thick. The subsoil is about 35 inches thick. The upper part is brown, friable silty clay loam. The middle part is brown, mottled, firm silty clay loam. The lower part is yellowish brown, mottled, very firm silty clay loam. Bedrock is at a depth of about 41 inches. In some places the surface layer is silt loam.

Included with this soil in mapping are small areas of Eram and Kenoma soils. The moderately deep Eram soils are on side slopes. The deep, moderately well drained Kenoma soils are on ridgetops. Included soils make up about 10 to 15 percent of this unit.

Permeability is moderately slow, and available water capacity is moderate. Surface runoff is medium. Organic matter content is moderately low, and natural fertility is low. The surface layer is firm and is difficult to till. The root zone is restricted by bedrock at about 41 inches. The shrink-swell potential is moderate.

About two-thirds of the acreage is cultivated. The rest is mostly abandoned cropland. The potential is good for cultivated crops, windbreak and environmental plantings, and range. It is fair for openland wildlife habitat. It is fair for building site development and sanitary facilities.

This soil is well suited to wheat and grain sorghum and to grasses and legumes for hay and pasture. Further erosion is a hazard if this soil is cultivated. Minimum tillage, grassed waterways, terraces, and contour farming reduce soil loss and conserve moisture. Returning crop residue and other organic material to the soil improves fertility and soil tilth.

This soil is suited to range. The major limitations in range management are related to the low forage production of abandoned cropland and to the hazard of erosion. Reseeding abandoned cropland with desirable mid and tall grasses improves forage production. An adequate plant cover and ground mulch are needed to reduce runoff, prevent excessive soil loss, and improve the moisture supplying capacity. Overgrazing reduces the protective cover and causes deterioration of the plant community. The more desirable grasses are replaced by less productive mid and short grasses and by weeds. Proper stocking, deferred grazing, and brush management are needed to keep the range in good condition.

This soil is well suited to windbreak and environmental plantings. Selecting adapted species and preparing the site to control erosion and competing vegetation help in establishing plantings. Protection from livestock and fire is needed.

The shrink-swell potential is a moderate limitation for dwellings. Properly designed and reinforced foundations, foundation drains, and backfill of sand or gravel reduce the risk of structural damage. Moderately slow permeability is a severe limitation for septic tank absorption fields. Slope is a moderate limitation for sewage lagoons. Onsite investigation is needed to locate deeper soils in less sloping areas that are more suitable for sewage lagoons. Low strength is a severe limitation for local roads and streets. Strengthening or replacing the base material reduces this limitation.

The capability subclass is IIIe.

Ed—Eram silt loam, 3 to 6 percent slopes. This moderately sloping, moderately well drained soil is on side slopes. Individual areas are irregular in shape and range from 10 to 80 acres.

Typically the surface layer is dark grayish brown silt loam about 9 inches thick. The subsoil is about 25 inches thick. It is brown, mottled, extremely firm and very firm silty clay. Bedrock is at a depth of about 34 inches. In some places the surface layer is silty clay loam.

Included with this soil in mapping are small areas of Bates and Elmont soils. The well drained Bates soils are on ridgetops. The deep Elmont soils are on foot slopes. Included soils make up about 10 to 15 percent of the unit.

Permeability is slow, and available water capacity is moderate. Surface runoff is medium. The organic matter content is moderate, and natural fertility is medium. The root zone is restricted by bedrock at about 34 inches. The surface layer is friable and is easy to till. A seasonal perched water table is 2 to 3 feet below the surface in winter and spring. The shrink-swell potential is high.

About half the acreage is range. The rest is mostly cultivated. The potential is good for range and for openland and rangeland wildlife habitat. It is fair for cultivated crops and for windbreak and environmental plantings. It is poor for building site development and sanitary facilities.

This soil is moderately well suited to grain sorghum and wheat and to grasses and legumes for hay and pasture. Erosion is a hazard in cultivated areas. Minimum tillage, grassed waterways, terraces, and contour farming reduce soil loss and conserve moisture. Returning crop residue to the soil helps in maintaining the organic matter content and soil tilth.

This soil is well suited to range. Overgrazing reduces the vigor and growth of grasses. Proper stocking and rotation grazing are needed to keep the range in good condition.

This soil is moderately well suited to windbreak and environmental plantings. Selecting adapted species and preparing the site to control erosion and competing vegetation help in establishing plantings. Protection from livestock and fire is needed.

The shrink-swell potential is a severe limitation for dwellings without basements. Properly designed and reinforced foundations, foundation drains, and backfill of sand or gravel reduce the risk of structural damage. Slow permeability, wetness, and depth to rock are severe limitations for septic tank absorption fields. Depth to rock and the slope are moderate limitations for sewage lagoons. Onsite investigation is needed to locate deep soils in less sloping areas that are more suitable for sewage lagoons. Low strength and the shrink-swell potential are severe limitations for local roads and streets. Strengthening or replacing the base material reduces these limitations.

The capability subclass is IVe.

Ee—Eram silty clay loam, 3 to 6 percent slopes, eroded. This moderately sloping, moderately well drained soil is on side slopes. Individual areas are irregular in shape and range from 10 to 60 acres.

Erosion has removed most of the original surface layer. Typically the surface layer is dark grayish brown silty clay loam about 6 inches thick. The subsoil is about 19 inches thick. It is brown, mottled, extremely firm and very firm silty clay. Bedrock is at a depth of about 25 inches. In some places the surface layer is silt loam or silty clay.

Permeability is slow, and available water capacity is low. Surface runoff is medium. The organic matter content is moderately low, and natural fertility is low. The surface layer is very firm and is difficult to till. The root zone is restricted by bedrock at about 25 inches. A seasonal perched water table is 2 to 3 feet below the surface in winter and spring. The shrink-swell potential is high.

Included with this soil in mapping are small areas of Bates and Elmont soils. The well drained Bates soils are on ridgetops. The deep Elmont soils are on foot slopes. Included soils make up 10 to 15 percent of the map unit.

About half the acreage is cultivated. The rest is mostly abandoned cropland. The potential is good for range and openland wildlife habitat. It is fair for cultivated crops and for windbreak and environmental plantings. It is poor for building site development and sanitary facilities.

This soil is moderately well suited to wheat and grain sorghum and to grasses and legumes for hay and pasture. Further erosion is a hazard if this soil is cultivated. Minimum tillage, grassed waterways, terraces, and contour farming reduce soil loss and conserve moisture. Returning crop residue and other organic matter to the soil improves fertility and soil tilth.

This soil is suited to range. The major limitations in range management are related to the low forage production of abandoned cropland and to the hazard of erosion. Reseeding abandoned cropland with desirable mid and tall grasses improves forage production. An adequate plant cover and ground mulch are needed to reduce runoff, prevent excessive soil loss, and improve the moisture supplying capacity. Overgrazing reduces the protective cover and causes deterioration of the plant community. The more desirable grasses are replaced by less productive mid and short grasses and by weeds. Proper stocking, deferred grazing, and brush management are needed to keep the range in good condition.

This soil is moderately well suited to windbreak and environmental plantings. Selecting adapted species and preparing the site to control erosion and competing vegetation help in establishing plantings. Protection from livestock and fire is needed.

The shrink-swell potential is a severe limitation for dwellings without basements. Properly designed and reinforced foundations, foundation drains, and backfill of sand or gravel reduce the risk of structural damage. Slow permeability, wetness, and depth to rock are severe limitations for septic tank absorption fields. Depth

to rock and the slope are moderate limitations for sewage lagoons. Onsite investigation is needed to locate deep soils in less sloping areas that are more suitable for sewage lagoons. Low strength and the shrink-swell potential are severe limitations for local roads and streets. Strengthening or replacing the base material reduces these limitations.

The capability subclass is IVe.

Ef—Eram and Bates soils, 6 to 15 percent slopes. This map unit consists of strongly sloping, well drained and moderately well drained soils on side slopes. Individual areas are irregular in shape and range from 10 to 80 acres. About 70 percent of the total acreage is Eram soil and 30 percent is Bates soil. Some mapped areas are Eram soil, some are Bates soil, and some are both soils.

Typically the Eram soil has a surface layer of dark grayish brown silt loam about 7 inches thick. The subsoil is brown, extremely firm and very firm silty clay about 20 inches thick. Bedrock is at a depth of about 27 inches.

Typically the Bates soil has a surface layer of dark grayish brown loam about 7 inches thick. The subsoil is about 24 inches thick. The upper part is brown, friable loam. The middle part is dark brown, firm clay loam. The lower part is yellowish brown, firm clay loam. Bedrock is at a depth of about 31 inches.

Included with this unit in mapping are areas of deep Elmont and Ivan soils. Elmont soils are on foot slopes. Ivan soils are on narrow flood plains. Included soils make up 15 to 20 percent of the unit.

Permeability is slow in the Eram soil and moderate in the Bates soil. Surface runoff is rapid. Available water capacity is low in both soils. The root zone is restricted by bedrock at a depth of about 27 inches in the Eram soil and at about 31 inches in the Bates soil. The Eram soil has a seasonal perched water table 2 to 3 feet below the surface in winter and spring. The shrink-swell potential is high in the Eram soil and low in the Bates soil.

Most of the acreage is range. The potential is good for range and for openland and rangeland wildlife habitat. It is fair for windbreak and environmental plantings. It is poor for cultivated crops and for building site development and sanitary facilities.

This unit is best suited to range and pasture. The hazard of erosion is the major limitation. An adequate plant cover and ground mulch are needed to reduce runoff, prevent excessive soil loss, and improve the moisture supplying capacity. Overgrazing reduces the protective cover and causes deterioration of the plant community. The more desirable grasses are replaced by less productive short grasses and by weeds. Proper stocking, rotation grazing, and deferred grazing are needed to keep the range in good condition. Potential pond sites are numerous.

This unit is moderately well suited to windbreak and environmental plantings. Selecting adapted species and preparing the site to control erosion and competing vegetation help in establishing plantings. Protection from livestock and fire is needed.

The Bates soil is suitable for dwellings without basements. The shrink-swell potential in the Eram soil is a severe limitation for dwellings without basements. Properly designed and reinforced foundations, foundation drains, and backfill of sand or gravel reduce the risk of structural damage. Depth to rock in both soils and wetness and slow permeability in the Eram soil are severe limitations for septic tank absorption fields. Slope in both soils is a severe limitation for sewage lagoons. Locating lagoons in the less sloping Bates soil and sealing them reduces seepage. Low strength and the shrink-swell potential in the Eram soil are severe limitations for local roads and streets. Low strength in the Bates soil is a moderate limitation. Strengthening or replacing the base material reduces these limitations.

The capability subclass is VIe.

Fa—Florence-Labette complex, 2 to 12 percent slopes. This map unit consists of gently sloping to strongly sloping, well drained soils on ridgetops and side slopes. It is 50 to 70 percent Florence soil and 30 to 50 percent Labette soil. The Florence soil is on side slopes, and the Labette soil is on gently sloping ridgetops. Areas of these soils are so intricately mixed that it is not practical to map them separately. Individual areas are irregular in shape and range from 10 to 400 acres.

Typically the Florence soil has a surface soil of dark grayish brown cherty silt loam about 13 inches thick. The subsoil is about 33 inches thick. The upper part is dark brown, very firm cherty silty clay loam. The lower part is reddish brown, extremely firm cherty clay. Bedrock is at a depth of about 46 inches.

Typically the Labette soil has a surface layer of dark grayish brown silty clay loam about 8 inches thick. The subsoil is about 25 inches thick. The upper part is dark brown, firm silty clay loam. The middle part is brown, firm silty clay. The lower part is reddish brown, very firm silty clay. The underlying material is reddish brown silty clay. Bedrock is at a depth of about 38 inches. In some places the subsoil contains chert fragments.

Included with this unit in mapping are small areas of deep Kenoma and Tully soils. Kenoma soils are on ridgetops. Tully soils are on foot slopes. Included soils make up 10 to 15 percent of the unit.

Permeability is moderately slow in the Florence soil and slow in the Labette soil. Surface runoff is rapid. The available water capacity is low in the Florence soil and moderate in the Labette soil. The root zone is restricted by bedrock at a depth of about 46 inches in the Florence soil and at about 38 inches in the Labette soil. The shrink-swell potential is moderate in the Florence soil and high in the Labette soil.

Most of the acreage is range. The potential is good for range. It is fair for openland and rangeland wildlife habi-

tat and for windbreak and environmental plantings. It is poor for cultivated crops, building site development, and sanitary facilities.

This unit is best suited to range and pasture. The major limitation is the hazard of erosion. An adequate plant cover and ground mulch are needed to reduce runoff, prevent excessive soil loss, and improve the moisture supplying capacity. Overgrazing reduces the protective plant cover and causes deterioration of the plant community. The more desirable grasses are replaced by less productive short grasses and by weeds. Proper stocking, rotation grazing, and deferred grazing are needed to keep the range in good condition. Potential pond sites are numerous.

The Labette soil is moderately well suited to windbreak and environmental plantings. The Florence soil is generally not suited to trees. Selecting adapted species and preparing the site to control erosion and competing vegetation help in establishing plantings. Protection from livestock and fire is needed.

Large stones in the Florence soil and the shrink-swell potential in the Labette soil are severe limitations for dwellings. Properly designed and reinforced foundations, foundation drains, and backfill of sand or gravel reduce the risk of structural damage caused by shrinking and swelling. Depth to rock in both soils, moderately slow permeability in the Florence soil, and slow permeability in the Labette soil are severe limitations for septic tank absorption fields. Slope and large stones in the Florence soil and depth to rock in the Labette soil are severe limitations for sewage lagoons. Onsite investigation is needed to locate deep soils in less sloping areas that are more suitable for sewage lagoons. Low strength and large stones in the Florence soil and low strength and the shrink-swell potential in the Labette soil are severe limitations for local roads and streets. Strengthening or replacing the base material reduces these limitations.

The capability subclass is VIe.

Ia—Ivan silt loam. This nearly level, moderately well drained soil is on flood plains that are flooded frequently. Individual areas are irregular in shape and range from 10 to 80 acres.

Typically the surface soil is dark grayish brown silt loam about 20 inches thick. The next layer is grayish brown, friable silt loam about 15 inches thick. The underlying material to a depth of about 60 inches is grayish brown loam.

Included with this soil in mapping are small areas of the well drained Reading soils on stream terraces. These soils make up 5 to 10 percent of the unit.

Permeability is moderate, and available water capacity is high. Surface runoff is slow. The organic matter content is moderate, and natural fertility is high. The soil is calcareous throughout. In some places the surface soil is noncalcareous. The surface layer is friable and is easily tilled. The shrink-swell potential is moderate.

Most of the acreage is cultivated. A few areas are wooded. The potential is good for cultivated crops, windbreak and environmental plantings, and range and for openland, rangeland, and woodland wildlife habitat. It is poor for building site development and sanitary facilities.

This soil is well suited to corn, grain sorghum, wheat, and soybeans and to grasses and legumes for hay and pasture. Spring flooding sometimes delays harvesting wheat and planting crops. Returning crop residue to the soil helps in maintaining organic matter content and soil tilth.

This soil is well suited to range. Overgrazing reduces the vigor and growth of grasses. Proper stocking and rotation grazing are needed to keep the range in good condition.

This soil is well suited to windbreak and environmental plantings. Selecting adapted species and preparing the site to control competing vegetation help in establishing plantings.

The hazard of flooding is a severe limitation for dwellings, septic tank absorption fields, sewage lagoons, and local roads and streets. Dikes, levees, or other flood-control structures reduce this hazard.

The capability subclass is IIw.

Ib—Ivan silt loam, channeled. This nearly level, moderately well drained soil is on flood plains that are dissected by stream channels and are flooded frequently. Individual areas are long and are 200 to 500 feet wide. They range from 10 to 60 acres.

Typically the surface soil is dark grayish brown silt loam about 20 inches thick. The next layer is grayish brown, friable silt loam about 15 inches thick. The underlying material to a depth of about 60 inches is grayish brown loam.

Included with this soil in mapping are steep stream channels, scour plains, and gravel and rock bars. These areas make up 10 to 15 percent of the unit.

Permeability is moderate, and available water capacity is high. Surface runoff is slow. The organic matter content is moderate, and natural fertility is high. The soil is calcareous throughout. In some places the surface soil is noncalcareous. The shrink-swell potential is high.

Most of the acreage is range. A few areas are woodland. The potential is good for range, for windbreak and environmental plantings, and for openland, rangeland, and woodland wildlife habitat. It is poor for cultivated crops, building site development, and sanitary facilites.

This soil is well suited to range. Overgrazing reduces the vigor and growth of grasses. Proper stocking and rotation grazing are needed to keep the range in good condition.

This soil is well suited to windbreak and environmental plantings. Selecting adapted species and preparing the site to control competing vegetation help in establishing plantings. Protection from livestock and fire is needed.

The hazard of flooding is a severe limitation for dwellings, septic tank absorption fields, sewage lagoons, and local roads and streets. Dikes, levees, and other flood-control structures reduce this hazard.

The capability subclass is Vw.

Ka—Kenoma silt loam, 1 to 3 percent slopes. This gently sloping, moderately well drained soil is on ridgetops. Individual areas are irregular in shape and range from 20 to 400 acres.

Typically the surface layer is grayish brown silt loam about 10 inches thick. The subsoil extends to a depth of about 60 inches. The upper part is grayish brown, mottled, very firm silty clay. The lower part is brown, dark grayish brown, and yellowish brown, mottled, very firm silty clay. In some places the surface layer is silty clay loam.

Included with this soil in mapping are small areas of Ladysmith soils. Ladysmith soils have a darker colored subsoil. They are on broad ridgetops above this Kenoma soil. They make up about 5 to 10 percent of the unit.

Permeability is very slow, and available water capacity is high. Surface runoff is medium. Organic matter content is moderate, and natural fertility is medium. The surface layer is friable and is easily tilled. The shrink-swell potential is high.

About half the acreage is cultivated. The rest is mostly range. The potential is good for cultivated crops, windbreak and environmental plantings, range, and openland wildlife habitat. It is poor for building site development and sanitary facilities.

This soil is well suited to grain sorghum, wheat, and soybeans and to grasses and legumes for hay and pasture (fig. 4). Erosion is a hazard in cultivated areas. Minimum tillage, grassed waterways, terraces, and contour farming reduce soil loss. Returning crop residue to the soil helps in maintaining organic matter content, tilth, and fertility.

This soil is well suited to range. Overgrazing reduces the vigor and growth of the grasses. Proper stocking and rotation grazing are needed to keep the range in good condition.

This soil is well suited to windbreak and environmental plantings. Selecting adapted species and preparing the site to control erosion and competing vegetation help in establishing plantings. Protection from livestock and fire is needed.

Shrink-swell potential is a severe limitation for dwellings. Properly designed and reinforced foundations, foundation drains, and backfill of sand and gravel reduce the risk of structural damage. Very slow permeability is a severe limitation for septic tank absorption fields. Slope is a moderate limitation for sewage lagoons. The less sloping areas are suitable sites. Low strength and the shrink-swell potential are severe limitations for local roads and streets. Strengthening or replacing the base material reduces these limitations.

The capability subclass is IIIe.

Kb—Kenoma silty clay loam, 1 to 3 percent slopes, eroded. This gently sloping, moderately well drained soil is on ridgetops. Individual areas are irregular in shape and range from 10 to 80 acres.

Erosion has removed most of the original surface layer. Typically the present surface layer is grayish brown silty clay loam about 6 inches thick. The subsoil is about 45 inches thick. The upper part is grayish brown, very firm silty clay. The lower part is brown, dark grayish brown, and yellowish brown, mottled, very firm silty clay. The underlying material to a depth of about 60 inches is yellowish brown silty clay. In some places the surface layer is silt loam.

Included with this soil in mapping are small areas of Ladysmith soils. Ladysmith soils have a darker subsoil. They are on broad ridgetops above this Kenoma soil. They make up about 5 to 10 percent of the unit.

Permeability is very slow, and available water capacity is high. Surface runoff is medium. Organic matter content is moderately low, and natural fertility is low. The surface layer is firm and is difficult to till. The shrink-swell potential is high.

About two-thirds of the acreage is cultivated. The rest is mostly abandoned cropland. The potential is good for range and openland wildlife habitat. It is fair for cultivated crops and windbreak and environmental plantings. It is poor for building site development and sanitary facilities.

This soil is moderately well suited to wheat and grain sorghum and to grasses and legumes for hay and pasture. Further erosion is a hazard if this soil is cultivated. Minimum tillage, grassed waterways, terraces, and contour farming reduce soil loss. Returning crop residue or other organic material to the soil improves fertility and tilth.

This soil is suited to range. The major limitations in range management are related to the low forage production of abandoned cropland and to the hazard of erosion. Reseeding abandoned cropland with desirable mid and tall grasses improves forage production. An adequate plant cover and ground mulch are needed to reduce runoff, prevent excessive soil loss, and improve the moisture supplying capacity. Overgrazing reduces the protective cover and causes deterioration of the plant community. The more desirable grasses are replaced by less productive mid and short grasses and by weeds. Proper stocking, deferred grazing, and brush management are needed to keep the range in good condition.

This soil is moderately well suited to windbreak and environmental plantings. Selecting adapted species and preparing the site to control erosion and competing vegetation help in establishing plantings. Protection from livestock and fire is needed.

The shrink-swell potential is a severe limitation for dwellings. Properly designed and reinforced foundations, foundation drains, and backfill of sand or gravel reduce

the risk of structural damage. Very slow permeability is a severe limitation for septic tank absorption fields. Slope is a moderate limitation for sewage lagoons. The less sloping areas are suitable sites. Low strength and the shrink-swell potential are severe limitations for local roads and streets. Strengthening or replacing the base material reduces these limitations.

The capability subclass is IVe.

Kc—Kenoma silt loam, 3 to 6 percent slopes. This moderately sloping, moderately well drained soil is on side slopes. Individual areas are irregular in shape and range from 10 to 80 acres.

Typically the surface layer is grayish brown silt loam about 10 inches thick. The subsoil is about 48 inches thick. The upper part is grayish brown, very firm silty clay. The lower part is brown, dark grayish brown, and yellowish brown, mottled, very firm silty clay. The underlying material to a depth of 60 inches is yellowish brown silty clay. In some places the surface layer is silty clay loam.

Included with this soil in mapping are small areas of well drained Elmont soils on foot slopes. These soils make up about 10 to 15 percent of the unit.

Permeability is very slow, and available water capacity is high. Surface runoff is medium. The organic matter content is moderate, and natural fertility is medium. The surface layer is friable and is easily tilled. The shrink-swell potential is high.

About two-thirds of the acreage is range. Most of the rest is cultivated. The potential is good for range and openland wildlife habitat. It is fair for cultivated crops and windbreak and environmental plantings. It is poor for building site development and sanitary facilities.

This soil is moderately well suited to wheat and grain sorghum and to grasses and legumes for hay and pasture. Erosion is a hazard in cultivated areas. Minimum tillage, grassed waterways, terraces, and contour farming reduce soil loss. Returning crop residue to the soil helps to maintain tilth and the organic matter content and improves fertility.

This soil is well suited to range. Overgrazing reduces the vigor and growth of the grasses. Proper stocking and rotation grazing are needed to keep the range in good condition.

This soil is moderately well suited to windbreak and environmental plantings. Selecting adapted species and preparing the site to control erosion and competing vegetation help in establishing plantings. Protection from livestock and fire is needed.

The shrink-swell potential is a severe limitation for dwellings. Properly designed and reinforced foundations, foundation drains, and backfill of sand or gravel reduce the risk of structural damage. Very slow permeability is a severe limitation for septic tank absorption fields. Slope is a moderate limitation for sewage lagoons. Onsite investigation is needed to locate deep soils in less sloping areas that are more suitable for sewage lagoons. Low strength and the shrink-swell potential are severe limitations for local roads and streets. Strengthening or replacing the base material reduces these limitations.

The capability subclass is IVe.

Kd—Kenoma silty clay loam, 3 to 6 percent slopes, eroded. This moderately sloping, moderately well drained soil is on side slopes. Individual areas are irregular in shape and range from 10 to 60 acres.

Erosion has removed most of the original surface layer. Typically the present surface layer is grayish brown silty clay loam about 6 inches thick. The subsoil is about 40 inches thick. The upper part is grayish brown, very firm silty clay. The lower part is brown, dark grayish brown, and yellowish brown, mottled, very firm silty clay. The underlying material to a depth of about 60 inches is yellowish brown silty clay. In some places the surface layer is silt loam.

Included with this soil in mapping are small areas of well drained Elmont soils on foot slopes. These soils make up about 10 to 15 percent of the unit.

Permeability is very slow, and available water capacity is high. Surface runoff is medium. Organic matter content is moderately low, and natural fertility is low. The surface layer is firm and is difficult to till. The shrink-swell potential is high.

About half the acreage is cultivated. The rest is mostly abandoned cropland. The potential is good for range and openland wildlife habitat. It is fair for cultivated crops and windbreak and environmental plantings. It is poor for building site development and sanitary facilities.

This soil is moderately well suited to wheat and grain sorghum and to grasses and legumes for hay and pasture. Further erosion is a hazard if this soil is cultivated. Minimum tillage, grassed waterways, terraces, and contour farming reduce soil loss. Returning crop residue or other organic material to the soil helps to improve fertility and soil tilth.

This soil is suited to range. The major limitations in range management are related to the low forage production of abandoned cropland and to the hazard of erosion. Reseeding abandoned cropland with desirable mid and tall grasses improves forage production. An adequate plant cover and ground mulch are needed to reduce runoff, prevent excessive soil loss, and improve the moisture supplying capacity. Overgrazing reduces the protective cover and causes deterioration of the plant community. The more desirable grasses are replaced by less productive mid and short grasses and by weeds. Proper stocking, deferred grazing, and brush management are needed to keep the range in good condition.

This soil is moderately well suited to windbreak and environmental plantings. Selecting adapted species and preparing the site to control erosion and competing vegetation help in establishing plantings. Protection from livestock and fire is needed.

The shrink-swell potential is a severe limitation for dwellings. Properly designed and reinforced foundations, foundation drains, and backfill of sand or gravel reduce the risk of structural damage. The very slow permeability is a severe limitation for septic tank absorption fields. The slope is a moderate limitation for sewage lagoons. Onsite investigation is needed to locate deeper soils in less sloping areas that are more suitable for sewage lagoons. Low strength and the shrink-swell potential are severe limitations for local roads and streets. Strengthening or replacing the base material reduces these limitations.

The capability subclass is IVe.

La—Labette silty clay loam, 1 to 3 percent slopes. This gently sloping, well drained soil is on ridgetops. Individual areas are irregular in shape and range from 5 to 60 acres.

Typically the surface layer is dark grayish brown silty clay loam about 8 inches thick. The subsoil is about 25 inches thick. The upper part is dark brown, firm silty clay loam. The middle part is brown, firm silty clay. The lower part is reddish brown, very firm silty clay. The underlying material is reddish brown silty clay. Bedrock is at a depth of about 38 inches. In some places the soil contains a few chert fragments.

Included with this soil in mapping are small areas of deep Kenoma and Zaar soils. Kenoma soils are on ridgetops. Zaar soils are on foot slopes. Included soils make up about 10 to 15 percent of this unit.

Permeability is slow, and available water capacity is moderate. Surface runoff is medium. The organic matter content is moderate, and natural fertility is medium. The surface layer is friable and is easily tilled. The root zone is restricted by bedrock at about 38 inches. The shrink-swell potential is high.

About half the acreage is cultivated. The rest is mostly range. The potential is good for cultivated crops, windbreak and environmental plantings, and range. It is fair for openland, rangeland, and woodland wildlife habitat. It is poor for building site development and sanitary facilities.

This soil is well suited to grain sorghum, wheat, and soybeans and to grasses and legumes for hay and pasture. Erosion is a hazard in cultivated areas. Minimum tillage, grassed waterways, terraces, and contour farming reduce soil loss and conserve moisture. Returning crop residue to the soil helps in maintaining organic matter content and soil tilth.

This soil is well suited to range. Overgrazing reduces the vigor and growth of grasses. Proper stocking and rotation grazing are needed to keep the range in good condition.

This soil is well suited to windbreak and environmental plantings. Selecting adapted species and preparing the site to control erosion and competing vegetation help in establishing plantings. Protection from livestock and fire is needed.

The shrink-swell potential is a severe limitation for dwellings without basements. Properly designed and reinforced foundations, foundation drains, and backfill of sand or gravel reduce the risk of structural damage. Depth to rock and the slow permeability are severe limitations for septic tank absorption fields. Depth to rock is a severe limitation for sewage lagoons. Onsite investigation is needed to locate deep soils in less sloping areas that are more suitable for sewage lagoons. Low strength and the shrink-swell potential are severe limitations for local roads and streets. Strengthening or replacing the base material reduces these limitations.

The capability subclass is IIe.

Lb—Labette silty clay loam, 3 to 6 percent slopes. This moderately sloping, well drained soil is on side slopes. Individual areas of this unit are irregular in shape and range from 5 to 25 acres.

Typically the surface layer is dark grayish brown silty clay loam about 8 inches thick. The subsoil is about 20 inches thick. The upper part is dark brown, firm silty clay loam. The middle part is brown, firm silty clay. The lower part is reddish brown, very firm silty clay. The underlying material is reddish brown silty clay. Bedrock is at a depth of about 38 inches. In some places the soil contains a few chert fragments.

Included with this soil in mapping are small areas of deep Martin soils on foot slopes. These soils make up about 10 to 15 percent of this unit.

Permeability is slow, and available water capacity is moderate. Surface runoff is medium. The organic matter content is moderate, and natural fertility is medium. The surface layer is friable and is easily tilled. The root zone is restricted by bedrock at about 38 inches. The shrink-swell potential is high.

About one-third the acreage is cultivated. The rest is mostly range. The potential is good for range. It is fair for cultivated crops, windbreak and environmental plantings, and openland wildlife habitat. It is poor for building site development and sanitary facilities.

This soil is moderately well suited to grain sorghum, wheat, and soybeans and to grasses and legumes for hay and pasture. Erosion is a hazard in cultivated areas. Minimum tillage, grassed waterways, terraces, and contour farming reduce soil loss and conserve moisture. Returning crop residue to the soil helps in maintaining organic matter content and soil tilth.

This soil is well suited to range. Overgrazing reduces the vigor and growth of grasses. Proper stocking and rotation grazing are needed to keep the range in good condition.

This soil is moderately well suited to windbreak and environmental plantings. Selecting adapted species and preparing the site to control erosion and competing

vegetation help to establish plantings. Protection from livestock and fire is needed.

The shrink-swell potential is a severe limitation for dwellings without basements. Properly designed and reinforced foundations, foundation drains, and backfill of sand and gravel reduce the risk of structural damage. Depth to rock and the slow permeability are severe limitations for septic tank absorption fields. Depth to rock is a severe limitation for sewage lagoons. Onsite investigation is needed to locate deep soils in less sloping areas that are more suitable for sewage lagoons. Low strength and the shrink-swell potential are severe limitations for local roads and streets. Strengthening or replacing the base material reduces these limitations.

The capability subclass is IIIe.

Lc—Labette silty clay loam, 2 to 6 percent slopes, eroded. This moderately sloping, well drained soil is on side slopes. Individual areas of this unit are irregular in shape and range from 5 to 25 acres.

Erosion has removed most of the original surface layer. Typically the present surface layer is grayish brown silty clay loam about 4 inches thick. The subsoil is about 20 inches thick. The upper part is dark brown, firm silty clay loam. The middle part is brown, firm silty clay. The lower part is reddish brown, very firm silty clay. The underlying material is reddish brown silty clay. Bedrock is at a depth of about 30 inches. In some places the surface layer is less clayey than is typical.

Included with this soil in mapping are small areas of deep Martin soils on foot slopes. These soils make up about 10 to 15 percent of this unit.

Permeability is slow, and available water capacity is moderate. Surface runoff is medium. The organic matter content is moderately low, and fertility is low. The surface layer is firm and is difficult to till. The root zone is restricted by bedrock at about 30 inches. The shrink-swell potential is high.

About half the acreage is cultivated. The rest is mostly abandoned cropland. The potential is good for range. It is fair for cultivated crops, for windbreak and environmental plantings, and for openland, rangeland, and woodland wildlife habitat. It is poor for building site development and sanitary facilities.

This soil is moderately well suited to wheat and grain sorghum and to grasses and legumes for hay and pasture. Further erosion is a hazard if this soil is cultivated. Minimum tillage, grassed waterways, terraces, and contour farming reduce soil loss and conserve moisture. Returning crop residue and other organic material to the soil improves fertility and soil tilth.

This soil is suited to range. The major limitations in range management are related to the low forage production of abandoned cropland and to the hazard of erosion. Reseeding abandoned cropland with desirable mid and tall grasses improves forage production. An adequate plant cover and ground mulch are needed to reduce runoff, prevent excessive soil loss, and improve the moisture supplying capacity. Overgrazing reduces the protective cover and causes deterioration of the plant community. The more desirable grasses are replaced by less productive mid and short grasses and by weeds. Proper stocking, deferred grazing, and brush management are needed to keep the range in good condition.

This soil is moderately well suited to windbreak and environmental plantings. Selecting adapted species and preparing the site to control erosion and competing vegetation help in establishing plantings. Protection from livestock and fire is needed.

Shrink-swell potential is a severe limitation for dwellings without basements. Properly designed and reinforced foundations, foundation drains, and backfill of sand and gravel reduce the risk of structural damage. Depth to rock and the slow permeability are severe limitations for septic tank absorption fields. Depth to rock is a severe limitation for sewage lagoons. Onsite investigation is needed to locate deep soils in less sloping areas that are more suitable for sewage lagoons. Low strength and the shrink-swell potential are severe limitations for local roads and streets. Strengthening or replacing the base material reduces these limitations.

The capability subclass is IIIe.

Ld—Labette-Dwight complex, 0 to 2 percent slopes. This map unit consists of nearly level, well drained and moderately well drained soils on ridgetops. It is 50 to 70 percent Labette soil and 30 to 50 percent Dwight soil. The Dwight soil is in slight depressions. Areas of the soils are so intricately mixed that it is not practical to map them separately. Individual areas are irregular in shape and range from 10 to 100 acres.

Typically the Labette soil has a surface layer of dark grayish brown silty clay loam about 8 inches thick. The subsoil is about 25 inches thick. The upper part is dark brown, firm silty clay loam. The middle part is brown, firm silty clay. The lower part is reddish brown, very firm silty clay. The underlying material is reddish brown silty clay. Bedrock is at a depth of about 38 inches. In some places the subsoil contains chert fragments. In some places the surface layer is silt loam.

Typically the Dwight soil has a surface layer of dark gray silt loam about 4 inches thick. The subsoil is about 45 inches thick. The upper part is very dark grayish brown and brown, extremely firm silty clay. The lower part is brown, very firm silty clay. Bedrock is at a depth of about 49 inches.

Included with this unit in mapping are small areas of Elmont and Sogn soils. The deep Elmont soils are in concave depressions. The shallow Sogn soils are on side slopes below Labette soils. Included soils make up 10 to 15 percent of the unit.

Permeability is slow in the Labette soil and very slow in the Dwight soil. Surface runoff is slow. Available water capacity is moderate in the Labette soil and high in the

Dwight soil. The surface layer of the Labette soil is friable and is easily tilled. The surface layer of the Dwight soil has been mixed with the extremely firm subsoil in tillage. Thus, it is firm and is difficult to till. The subsoil of the Dwight soil has excess sodium. The shrink-swell potential in both soils is high.

Most of the acreage is range. A few areas are cultivated. The potential is fair for cultivated crops, windbreak and environmental plantings, range, and rangeland wildlife habitat. It is poor for building site development and sanitary facilities.

This map unit is moderately well suited to wheat and grain sorghum and to grasses and legumes for hay and pasture. Erosion is a hazard in cultivated areas. Minimum tillage, grassed waterways, terraces, and contour farming reduce soil loss. Returning crop residue to the soil helps to maintain organic matter content and improves fertility and soil tilth.

This soil is moderately well suited to range. Overgrazing reduces the vigor and growth of grasses. Proper stocking and rotation grazing are needed to keep the range in good condition.

This soil is moderately well suited to windbreak and environmental plantings. Selecting adapted species and preparing the site to control erosion and competing vegetation help in establishing plantings. Protection from livestock and fire is needed.

The shrink-swell potential in both soils is a severe limitation for dwellings. Properly designed and reinforced foundations, foundation drains, and backfill of sand and gravel reduce the risk of structural damage. Slow permeability and the depth to rock in both soils are severe limitations for septic tank absorption fields. Depth to rock in the Labette soil is a severe limitation for sewage lagoons. It is a moderate limitation in the Dwight soil. Onsite investigation is needed to locate deep soils that are more suitable for sewage lagoons. Low strength and the shrink-swell potential in both soils are severe limitations for local roads and streets. Strengthening or replacing the base material reduces these limitations.

The capability subclass is IIIe.

Le—Ladysmith silty clay loam, 0 to 2 percent slopes. This nearly level, moderately well drained soil is on ridgetops. Individual areas are irregular in shape and range from 20 to 400 acres.

Typically the surface layer is dark gray silty clay loam about 8 inches thick. The subsoil is about 29 inches thick. The upper part is dark gray, very firm silty clay. The lower part is dark grayish brown, mottled, very firm silty clay. The underlying material, to a depth of about 60 inches, is light brownish gray and light gray silty clay loam. In some places the surface layer is silty clay.

Included with this soil in mapping are small areas of Kenoma and Martin soils. Kenoma soils have a browner subsoil than Ladysmith soils. They are on the more sloping ridgetops below Ladysmith soils. Martin soils have a thicker surface layer than Ladysmith soils. They are in slight depressions on ridgetops. Included soils make up 5 to 10 percent of the unit.

Permeability is very slow, and available water capacity is high. Surface runoff is slow. The organic matter content is moderate, and natural fertility is medium. The surface layer is friable and is easily tilled. The shrink-swell potential is high.

About three-fourths of the acreage is cultivated. The rest is mostly range. The potential is good for cultivated crops, windbreak and environmental plantings, and range and for openland and rangeland wildlife habitat. It is poor for building site development and sanitary facilities.

This soil is well suited to grain sorghum, wheat, and soybeans and to grasses and legumes for hay and pasture. The clay subsoil releases water slowly to plants. The soil is droughty during periods of low rainfall. Water sometimes ponds. Drainage ditches are needed. Minimum tillage, contour farming, and the return of crop residue to the soil help to maintain organic matter content and fertility, reduce crusting, and increase water infiltration.

This soil is well suited to range. Overgrazing reduces the vigor and growth of grasses. Proper stocking and rotation grazing are needed to keep the range in good condition.

This soil is well suited to windbreak and environmental plantings. Selecting adapted species and preparing the site to control erosion and competing vegetation help in establishing plantings. Protection from livestock and fire is needed.

The shrink-swell potential is a severe limitation for dwellings. Properly designed and reinforced foundations, foundation drains, and backfill of sand and gravel reduce the risk of structural damage. Slow permeability is a severe limitation for septic tank absorption fields. The soil is suitable for sewage lagoons. Low strength and the shrink-swell potential are severe limitations for local roads and streets. Strengthening or replacing the base material reduces these limitations.

The capability subclass is IIs.

Ma—Martin silty clay loam, 1 to 4 percent slopes. This gently sloping, moderately well drained soil is on foot slopes. Individual areas are long and narrow and range from 10 to 40 acres.

Typically the surface soil is dark gray silty clay loam about 13 inches thick. The subsoil extends to a depth of about 60 inches. The upper part is dark gray, firm silty clay. The middle part is very dark grayish brown and grayish brown, very firm silty clay. The lower part is light olive brown, mottled, extremely firm silty clay. In some places the surface soil is silty clay.

Included with this soil in mapping are small areas of Kenoma soils. Kenoma soils have a lighter surface layer than Martin soils. They are on less sloping lower foot slopes. They make up about 5 to 10 percent of the unit.

Permeability is slow, and available water capacity is high. Surface runoff is medium. The organic matter content is moderate, and natural fertility is high. The surface layer is friable and is easily tilled. The shrink-swell potential is high.

About half the acreage is cultivated. The rest is mostly range. The potential is good for cultivated crops, windbreak and environmental plantings, and range and for openland and rangeland wildlife habitat. It is poor for building site development and sanitary facilities.

This soil is well suited to grain sorghum, wheat, and soybeans and to grasses and legumes for hay and pasture. Erosion is a hazard in cultivated areas. Minimum tillage, grassed waterways, terraces, and contour farming reduce soil loss. Returning crop residue to the soil helps in maintaining organic matter content and soil tilth.

This soil is well suited to range. Overgrazing reduces the vigor and growth of grasses. Proper stocking, rotation grazing, and uniform grazing distribution are needed to keep the range in good condition.

This soil is well suited to windbreak and environmental plantings. Selecting adapted species and preparing the site to control erosion and competing vegetation help in establishing plantings. Protection from livestock and fire is needed.

The shrink-swell potential is a severe limitation for dwellings. Properly designed and reinforced foundations, foundation drains, and backfill of sand or gravel reduce the risk of structural damage. Slow permeability is a severe limitation for septic tank absorption fields. Increasing the size of the absorption field improves the functioning of septic tank systems. Slope is a moderate limitation for sewage lagoons. The less sloping areas are suitable sites. Low strength and shrink-swell potential are severe limitations for local roads and streets. Strengthening or replacing the base material reduces these limitations.

The capability subclass is IIe.

Mb—Martin silty clay loam, 4 to 7 percent slopes. This moderately sloping, moderately well drained soil is on foot slopes. Individual areas are long and rectangular and range from 10 to 80 acres.

Typically the surface soil is dark gray silty clay loam about 12 inches thick. The subsoil extends to a depth of about 60 inches. The upper part is dark gray, firm silty clay. The middle part is very dark grayish brown and grayish brown, very firm silty clay. The lower part is light olive brown, mottled, extremely firm silty clay. In some places the surface soil is silty clay and has poor tilth.

Included with this soil in mapping are small areas of Clime and Zaar soils. The moderately deep, calcareous Clime soils are on higher side slopes. The somewhat poorly drained Zaar soils are on lower foot slopes. These included soils make up 5 to 10 percent of the unit.

Permeability is slow, and available water capacity is high. Surface runoff is medium. The organic matter content is moderate, and natural fertility is high. The surface layer is friable and is easily tilled. The shrink-swell potential is high.

About half the acreage is cultivated. The rest is mostly range. The potential is good for cultivated crops, windbreak and environmental plantings, and range and for openland and rangeland wildlife habitat. It is poor for building site development and sanitary facilities.

This soil is well suited to grain sorghum, wheat, and soybeans and to grasses and legumes for hay or pasture. Erosion is a hazard in cultivated areas. Minimum tillage, grassed waterways, terraces, and contour farming reduce soil loss. Returning crop residue to the soil helps in maintaining organic matter content and soil tilth.

This soil is well suited to range. Overgrazing reduces the vigor and growth of grasses. Proper stocking, rotation grazing, and uniform grazing distribution are needed to keep the range in good condition.

This soil is well suited to windbreak and environmental plantings. Selecting adapted species and preparing the site to control erosion and competing vegetation help in establishing plantings. Protection from livestock and fire is needed.

The shrink-swell potential is a severe limitation for dwellings. Properly designed and reinforced foundations, foundation drains, and backfill of sand or gravel reduce the risk of structural damage. Slow permeability is a severe limitation for septic tank absorption fields. Increasing the size of the absorption field improves the functioning of septic tank systems. Slope is a moderate limitation for sewage lagoons. Onsite investigation is needed to locate deep soils in less sloping areas that are more suitable for sewage lagoons. Low strength and the shrink-swell potential are severe limitations for local roads and streets. Strengthening or replacing the base material reduces these limitations.

The capability subclass is IIIe.

Mc—Martin silty clay, 3 to 7 percent slopes, eroded. This moderately sloping, moderately well drained soil is on foot slopes. Individual areas are long and rectangular and range from 10 to 40 acres.

Erosion has removed most of the original surface layer. Typically the present surface layer is dark gray silty clay about 5 inches thick. The subsoil extends to a depth of about 60 inches. The upper part is dark gray, very firm silty clay. The middle part is very dark grayish brown and grayish brown, very firm silty clay. The lower part is light olive brown, mottled, extremely firm silty clay. In some places the surface layer is silty clay loam.

Included with this soil in mapping are small areas of moderately deep, calcareous Clime soils on higher side slopes. These soils make up 5 to 10 percent of this unit.

Permeability is slow, and available water capacity is high. Surface runoff is rapid. The organic matter content is moderately low, and natural fertility is medium. The

surface layer is very firm and is difficult to till. The shrink-swell potential is high.

About half the acreage is cultivated. The rest is mostly abandoned cropland. The potential is good for range and for openland and rangeland wildlife habitat. It is fair for cropland and windbreak and environmental plantings. It is poor for building site development and sanitary facilities.

This soil is moderately well suited to wheat and grain sorghum and to grasses and legumes for hay and pasture. Further erosion is a hazard if this soil is cultivated. Minimum tillage, grassed waterways, terraces, and contour farming reduce soil loss. Returning crop residue or other organic material to the soil improves fertility and soil tilth.

This soil is suited to range. The major limitations in range management are related to the low forage production of abandoned cropland and to the hazard of erosion. Reseeding abandoned cropland with desirable mid and tall grasses improves forage production. An adequate plant cover and ground mulch are needed to reduce runoff, prevent excessive soil loss, and improve the moisture supplying capacity. Overgrazing reduces the protective cover and causes deterioration of the plant community. The more desirable grasses are replaced by less productive mid and short grasses and by weeds. Proper stocking, deferred grazing, and brush management are needed to keep the range in good condition.

This soil is moderately well suited to windbreak and environmental plantings. Selecting adapted species and preparing the site to control erosion and competing vegetation help in establishing plantings. Protection from livestock and fire is needed.

The shrink-swell potential is a severe limitation for dwellings. Properly designed and reinforced foundations, foundation drains, and backfill of sand or gravel reduce the risk of structural damage. Slow permeability is a severe limitation for septic tank absorption fields. Increasing the size of the absorption field improves the functioning of septic tank systems. Slope is a moderate limitation for sewage lagoons. Onsite investigation is needed to locate deep soils in less sloping areas that are more suitable for sewage lagoons. Low strength and the shrink-swell potential are severe limitations for local roads and streets. Strengthening or replacing the base material reduces these limitations.

The capability subclass is IVe.

Oa—Olpe-Kenoma complex, 3 to 15 percent slopes. This map unit consists of moderately sloping to strongly sloping, well drained and moderately well drained soils on side slopes and ridgetops. It is 50 to 70 percent Olpe soil and 30 to 50 percent Kenoma soil. The Olpe soil is on strongly sloping side slopes and ridgetops. The Kenoma soil is on the less sloping ridgetops. Areas of the soils are so intricately mixed that it is not practical to map them separately. Individual areas of this unit are irregular in shape and range from 10 to 200 acres.

Typically the Olpe soil has a surface soil of dark grayish brown and brown gravelly silt loam about 15 inches thick. The subsoil extends to a depth of about 60 inches. The upper part is reddish brown, firm gravelly silty clay loam. The lower part is reddish brown, mottled, extremely firm gravelly silty clay.

Typically the Kenoma soil has a grayish brown silt loam surface layer about 10 inches thick. The subsoil extends to a depth of about 60 inches. The upper part is brown and grayish brown, mottled, very firm silty clay. The lower part is yellowish brown, mottled, very firm silty clay.

Included with this unit in mapping are small areas of Collinsville, Elmont, and Sogn soils. The shallow Collinsville and Sogn soils are less sloping soils on lower side slopes. The deep Elmont soils are on foot slopes. Included soils make up 15 to 20 percent of the unit.

Permeability is slow in the Olpe soil and very slow in the Kenoma soil. Surface runoff is rapid. The available water capacity is low in the Olpe soil and high in the Kenoma soil. The shrink-swell potential is moderate in the Olpe soil and high in the Kenoma soil.

Most of the acreage is range. The potential is good for range. It is fair for openland wildlife habitat and windbreak and environmental plantings. It is poor for cultivated crops, most building site development, and sanitary facilities.

This unit is best suited to range and pasture. The major limitation is the hazard of erosion. An adequate plant cover and ground mulch are needed to reduce runoff, prevent excessive soil loss, and improve the moisture supplying capacity. Overgrazing reduces the protective plant cover and causes deterioration of the plant community. The more desirable grasses are replaced by less productive short grasses and by weeds. Proper stocking, rotation grazing, and deferred grazing are needed to keep the range in good condition. Potential pond sites are numerous.

This soil is moderately well suited to windbreak and environmental plantings. The Olpe soil is generally not suited to trees. Selecting adapted species and preparing the site to control erosion and competing vegetation help in establishing plantings. Protection from livestock and fire is needed.

The shrink-swell potential and slope in the Olpe soil are moderate limitations for dwellings. The shrink-swell potential is a severe limitation in the Kenoma soil. Locating dwellings in less sloping areas, properly designing and reinforcing foundations, installing foundation drains, and backfilling with sand and gravel reduce the risk of structural damage. Slow permeability in the Olpe soil and very slow permeability in the Kenoma soil are severe limitations for septic tank absorption fields. Increasing the size of the absorption field improves the functioning of septic tank systems in the Olpe soil. Slope is a severe

limitation for sewage lagoons in the Olpe soil and a moderate limitation in the Kenoma soil. Onsite investigation is needed to locate deep soils in less sloping areas that are more suitable for sewage lagoons. The shrink-swell potential and the slope are moderate limitations for local roads and streets in the Olpe soil. Low strength and the shrink-swell potential are severe limitations in the Kenoma soil. Strengthening or replacing the base material reduces these limitations.

The capability subclass is VIe.

Ob—Orthents, clayey. This map unit consists of soil material excavated from sand and gravel pits. The overburden from these excavations is stockpiled in mounds adjacent to the pits. The mounds form a hummocky or hilly topography. The pits are commonly filled with water.

The soil material is similar in texture to adjacent bottom land soils and is mostly silty clay loam and silty clay. Most of the material has a high shrink-swell potential.

The pits provide water-related recreation. This unit provides feeding areas for wildlife if vegetation is reestablished. Cottonwood trees are common invaders. No interpretations in use and management are made for this map unit because the material is variable.

Oc—Osage silty clay. This nearly level, poorly drained soil is on flood plains that are flooded frequently. Individual areas are long and irregular and range from 10 to 1,000 acres.

Typically the surface soil is dark gray silty clay about 13 inches thick. The subsoil extends to a depth of about 60 inches. It is dark gray and gray, extremely firm silty clay. In some places the surface soil is silty clay loam.

Included with this soil in mapping are small areas of Chase and Reading soils. The moderately well drained Chase soils are on low stream terraces. The well drained Reading soils are on stream terraces. Included soils make up 10 to 15 percent of the unit.

Permeability is very slow, and available water capacity is high. Surface runoff is slow. Organic matter content is moderate, and natural fertility is high. The surface layer is very firm and is difficult to till. A seasonal perched water table is within a depth of 1 foot in winter and spring. The shrink-swell potential is high.

About two-thirds of the acreage is cultivated. The rest is mostly hayland. The potential is good for range and windbreak and environmental plantings. It is fair for cultivated crops and for openland, rangeland, and woodland wildlife habitat. It is poor for building site development and sanitary facilities.

This soil is moderately well suited to grain sorghum, wheat, and soybeans and to grasses and legumes for hay and pasture. Frequent flooding and ponding delay spring planting. Drainage ditches are needed in cultivated areas. Returning crop residue or other organic material to the soil improves soil tilth.

This soil is well suited to range. Overgrazing reduces the vigor and growth of grasses. Proper use and rotation grazing are needed to maintain the range in good condition.

This soil is well suited to windbreak and environmental plantings. Selecting adapted species and preparing the site to control competing vegetation help in establishing plantings.

The hazard of flooding is a severe limitation for dwellings, septic tank absorption fields, sewage lagoons, and local roads and streets. Dikes, levees, or other flood-control structures reduce this hazard.

The capability subclass is IIIw.

Ra—Reading silt loam. This nearly level, well drained soil is on stream terraces that are rarely flooded. Individual areas are long and irregular in shape and range from 10 to 400 acres.

Typically the surface soil is dark grayish brown silt loam about 17 inches thick. The subsoil extends to a depth of about 60 inches. The upper part is dark brown, firm silty clay loam. The lower part is dark yellowish brown and yellowish brown, firm silty clay loam.

Included with this soil in mapping are small areas of well drained Ivan soils on flood plains. These soils make up 5 to 10 percent of the unit.

Permeability is moderately slow, and available water capacity is high. Surface runoff is slow. The organic matter content is moderate, and natural fertility is high. The surface layer is friable and is easily tilled. The shrink-swell potential is moderate.

Most of the acreage is cultivated. A few areas are range. The potential is good for cultivated crops, windbreak and environmental plantings, and range and for openland, rangeland, and woodland wildlife habitat. It is fair to poor for building site development and sanitary facilities.

This soil is well suited to corn, wheat, and soybeans and to grasses and legumes for hay and pasture. Minimum tillage and the return of crop residue to the soil help to maintain organic matter content and soil tilth, improve fertility, and increase water infiltration (fig. 5).

This soil is well suited to range. Overgrazing reduces the vigor and growth of grasses. Proper stocking and rotation grazing are needed to keep the range in good condition.

This soil is well suited to windbreak and environmental plantings. Selecting adapted species and preparing the site to control competing vegetation help in establishing plantings.

The hazard of flooding is a severe limitation for dwellings. Dikes, levees, or other flood-control structures reduce this hazard. Moderately slow permeability is a severe limitation for septic tank absorption fields. Increasing the size of the absorption field improves the functioning of septic tank systems. The systems need to be adequately protected from flooding. Seepage is a

moderate limitation for sewage lagoons. Sealing the lagoons reduces seepage. Sewage lagoons need to be adequately protected from flooding. Low strength is a severe limitation for local roads and streets. Strengthening or replacing the base material reduces this limitation.

The capability class is I.

Ta—Tully silty clay loam, 2 to 7 percent slopes. This moderately sloping, well drained soil is on foot slopes. Individual areas of this unit are irregular in shape and range from 20 to 100 acres.

Typically the surface layer is dark grayish brown silty clay loam about 10 inches thick. The subsoil extends to a depth of about 60 inches. The upper part is dark grayish brown, firm silty clay loam. The middle part is dark grayish brown and grayish brown, firm and very firm silty clay. The lower part is brown, firm silty clay. In some places, material from the upper part of the subsoil has been mixed with the surface layer through plowing.

Included with this soil in mapping are small areas of Clime and Kenoma soils. The moderately deep, calcareous Clime soils are on side slopes. The moderately well drained Kenoma soils are on ridgetops. Included soils make up 10 to 15 percent of the unit.

Permeability is slow, and available water capacity is high. Surface runoff is medium. The organic matter content is moderate, and natural fertility is medium. The surface layer is friable and is easily tilled. The shrink-swell potential is high.

About one-third the acreage is cultivated. The rest is mostly range. The potential is good for cultivated crops, windbreak and environmental plantings, range, and openland wildlife habitat. It is poor for building site development and sanitary facilities.

This soil is well suited to grain sorghum, wheat, and soybeans and to grasses and legumes for hay and pasture. Erosion is a hazard in cultivated areas. Minimum tillage, grassed waterways, terraces, and contour farming reduce soil loss. Returning crop residue to the soil helps in maintaining organic matter content and soil tilth.

This soil is well suited to range. Overgrazing reduces the vigor and growth of grasses. Proper stocking and rotation grazing are needed to keep the range in good condition.

This soil is well suited to windbreak and environmental plantings. Selecting adapted species and preparing the site to control erosion and competing vegetation help in establishing plantings. Protection from livestock and fire is needed.

The shrink-swell potential is a severe limitation for dwellings. Properly designed and reinforced foundations, foundation drains, and backfill of sand and gravel reduce the risk of structural damage. Slow permeability is a severe limitation for septic tank absorption fields. Increasing the size of the absorption field improves the functioning of septic tank systems. Slope is a moderate limitation for sewage lagoons. Onsite investigation is needed to locate less sloping areas that are more suitable for sewage lagoons. Low strength and the shrink-swell potential are severe limitations for local roads and streets. Strengthening or replacing the base material reduces these limitations.

The capability subclass is IIIe.

Tb—Tully silty clay loam, 3 to 7 percent slopes, eroded. This moderately sloping, well drained soil is on foot slopes. Individual areas are irregular in shape and range from 10 to 60 acres.

Erosion has removed most of the original surface layer. Typically the present surface layer is dark grayish brown silty clay loam about 5 inches thick. The subsoil is about 45 inches thick. The upper part is dark grayish brown, firm silty clay. The middle part is grayish brown, very firm silty clay. The lower part is brown, firm silty clay. The underlying material to a depth of about 60 inches is brown silty clay.

Included with this soil in mapping are small areas of Clime and and Kenoma soils. The moderately deep, calcareous Clime soils are on side slopes. The moderately well drained Kenoma soils are on ridgetops. Included soils make up about 10 to 15 percent of the unit.

Permeability is slow, and available water capacity is high. Surface runoff is medium. The organic matter content is moderately low, and natural fertility is low. The surface layer is firm and is difficult to till. The shrink-swell potential is high.

About two-thirds of the acreage is cultivated. The rest is mostly abandoned cropland. The potential is good for range. It is fair for cultivated crops, for windbreak and environmental plantings, and for openland, rangeland, and woodland wildlife habitat. It is poor for building site development and sanitary facilities.

This soil is moderately well suited to wheat and grain sorghum and to grasses and legumes for hay and pasture. Further erosion is a hazard if this soil is cultivated. Minimum tillage, grassed waterways, terraces, and contour farming reduce soil loss. Returning crop residue and other organic material to the soil improves fertility and soil tilth.

This soil is suited to range. The major limitations in range management are related to the low forage production of abandoned cropland and to the hazard of erosion. Reseeding abandoned cropland with desirable mid and tall grasses improves forage production. An adequate plant cover and ground mulch are needed to reduce runoff, prevent excessive soil loss, and improve the moisture supplying capacity. Overgrazing reduces the protective cover and causes deterioration of the plant community. The more desirable grasses are replaced by less productive mid and short grasses and by weeds. Proper stocking, deferred grazing, and brush management are needed to keep the range in good condition.

This soil is moderately well suited to windbreak and environmental plantings. Selecting adapted species and

preparing the site to control erosion and competing vegetation help in establishing plantings. Protection from livestock and fire is needed.

The shrink-swell potential is a severe limitation for dwellings. Properly designed and reinforced foundations, foundation drains, and backfill of sand and gravel reduce the risk of structural damage. Slow permeability is a severe limitation for septic tank absorption fields. Increasing the size of the absorption field improves the functioning of septic tank systems. Slope is a moderate limitation for sewage lagoons. Onsite investigation is needed to locate less sloping areas that are more suitable for sewage lagoons. Low strength and the shrink-swell potential are severe limitations for local roads and streets. Strengthening or replacing the base material reduces these limitations.

The capability subclass is IIIe.

Tc—Tully-Clime complex, 7 to 15 percent slopes. This map unit consists of strongly sloping, well drained and moderately well drained soils on side slopes and ridgetops. It is 70 to 90 percent Tully soil and 10 to 30 percent Clime soil. The Tully soil is on the steeper side slopes. The Clime soil is on the less sloping ridgetops. Areas of these soils are so intricately mixed that it is not practical to map them separately. Individual areas are irregular in shape and range from 20 to 200 acres.

Typically the Tully soil has a surface layer of dark grayish brown silty clay loam about 10 inches thick. The subsoil extends to a depth of about 60 inches. The upper part is dark grayish brown, firm silty clay loam. The middle part is dark grayish brown and grayish brown, firm and very firm silty clay. The lower part is brown, firm silty clay.

Typically the Clime soil has a surface layer of dark grayish brown silty clay about 8 inches thick. The subsoil is grayish brown, very firm silty clay about 11 inches thick. The underlying material is light olive gray silty clay. Bedrock is at a depth of about 34 inches. In some places limestone fragments are on the surface.

Included with this unit in mapping are small areas of shallow Sogn soils on the less sloping upper side slopes. These soils make up 5 to 10 percent of the unit.

Permeability is slow. The available water capacity is high in the Tully soil and low in the Clime soil. Surface runoff is rapid. The Clime soil is calcareous throughout. The root zone in the Clime soil is restricted by bedrock at about 34 inches. The shrink-swell potential is high in the Tully soil and moderate in the Clime soil.

Most of the acreage is range. The potential is good for range. It is fair for openland and rangeland wildlife habitat and windbreak and environmental plantings. It is poor for cultivated crops, building site development, and sanitary facilities.

This unit is best suited to range and pasture. The major limitation is the hazard of erosion. An adequate plant cover and ground mulch are needed to reduce runoff, prevent excessive soil loss, and improve the moisture supplying capacity. Overgrazing reduces the protective plant cover and causes deterioration of the plant community. The more desirable grasses are replaced by less productive short grasses and by weeds. Proper stocking, rotation grazing, and deferred grazing are needed to keep the range in good condition. Potential pond sites are numerous.

This soil is moderately well suited to windbreak and environmental plantings. Selecting adapted species and preparing the site to control erosion and competing vegetation help in establishing plantings. Protection from livestock and fire is needed.

The shrink-swell potential in the Tully soil is a severe limitation for dwellings without basements. The shrink-swell potential and slope are moderate limitations in the Clime soil. Properly designed and reinforced foundations, foundation drains, and backfill of sand or gravel reduce the risk of structural damage. Slow permeability and depth to rock in the Clime soil are severe limitations for septic tank absorption fields. Slow permeability is a severe limitation in the Tully soil. Increasing the size of absorption fields in the Tully soil improves the functioning of septic tank systems. Slope is a severe limitation for sewage lagoons in both soils. Onsite investigation is needed to locate deep soils in less sloping areas that are more suitable for sewage lagoons. Low strength in both soils and the shrink-swell potential in the Tully soil are severe limitations for local roads and streets. Strengthening or replacing the base material reduces these limitations.

The capability subclass is VIe.

Va—Vinland loam, 4 to 10 percent slopes. This moderately sloping, somewhat excessively drained soil is on side slopes. Individual areas are irregular in shape and range from 10 to 40 acres.

Typically the surface layer is dark grayish brown loam about 7 inches thick. The subsoil is dark grayish brown, friable loam about 5 inches thick. The underlying material is brown loam. Bedrock is at a depth of about 19 inches.

Included with this soil in mapping are small areas of moderately deep Bates and Eram soils. Both soils are on lower foot slopes. They make up 10 to 15 percent of the unit.

Permeability is moderate, and available water capacity is very low. Surface runoff is medium. Root development is restricted by bedrock at about 19 inches.

Most of the acreage is range. A few areas are cultivated with the adjoining cultivated soils. The potential is good for range. It is fair for rangeland wildlife habitat. It is poor for cultivated crops, windbreak and environmental plantings, building site development, and sanitary facilities.

This unit is best suited to range. The major limitations in range management are the hazards of erosion and droughtiness because of the very low available water

capacity. An adequate plant cover and ground mulch are needed to reduce runoff, prevent excessive soil loss, and improve the moisture supplying capacity. Overgrazing reduces the vigor and growth of grasses and causes deterioration of the plant community. The more desirable grasses are replaced by less productive mid and short grasses and by weeds. Proper stocking, rotation grazing, and uniform grazing distribution are needed to keep the range in good condition. Potential pond sites are numerous.

Depth to rock is a moderate limitation for dwellings without basements and for local roads and streets. It is a severe limitation for septic tank absorption fields. Depth to rock and the slope are severe limitations for sewage lagoons. Onsite investigation is needed to locate adjoining deep soils in less sloping areas that are more suitable for sanitary facilities.

The capability subclass is VIe.

Za—Zaar silty clay, 2 to 5 percent slopes. This gently sloping, somewhat poorly drained soil is on foot slopes. Individual areas are irregular in shape and range from 20 to 200 acres.

Typically the surface soil is dark gray silty clay about 14 inches thick. The subsoil extends to a depth of about 60 inches. It is very dark grayish brown, dark grayish brown, and grayish brown, extremely firm silty clay.

Included with this soil in mapping are small areas of moderately deep, calcareous Clime soils on the upper part of foot slopes. These soils make up 10 to 15 percent of the unit.

Permeability is very slow and available water capacity is high. Surface runoff is medium. The organic matter content is moderate, and natural fertility is high. The surface layer is firm and is difficult to till. A seasonal perched water table is within 1 to 2 feet of the surface in winter and spring. The shrink-swell potential is high.

Most of the acreage is range. A few areas are cultivated. The potential is good for range. It is fair for cultivated crops, for windbreak and environmental plantings, and for openland and rangeland wildlife habitat. It is poor for building site development and sanitary facilities.

This soil is moderately well suited to wheat, grain sorghum, and soybeans and to grasses and legumes for hay and pasture. Erosion is a hazard in cultivated areas. Minimum tillage, grassed waterways, terraces, and contour farming reduce soil loss. Returning crop residue to the soil helps to maintain organic matter content and improve soil tilth.

This soil is well suited to range. Overgrazing reduces the vigor and growth of grasses. Proper stocking and rotation grazing are needed to keep the range in good condition.

This soil is moderately well suited to windbreak and environmental plantings. Selecting adapted species and preparing the site to control erosion and competing vegetation help in establishing plantings. Protection from livestock and fire is needed.

The shrink-swell potential and wetness are severe limitations for dwellings. Properly designed and reinforced foundations, foundation drains, and backfilling of sand or gravel reduce the risk of structural damage. Wetness and very slow permeability are severe limitations for septic tank absorption fields. Slope is a moderate limitation for sewage lagoons. Onsite investigation is needed to locate less sloping areas that are more suitable for sewage lagoons. Low strength and the shrink-swell potential are severe limitations for local roads and streets. Strengthening or replacing the base material reduces these limitations.

The capability subclass is IIIe.

Use and management of the soils

The soil survey is a detailed inventory and evaluation of the most basic resource of the survey area—the soil. It is useful in adjusting land use, including urbanization, to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in uses of the land.

While a soil survey is in progress, soil scientists, conservationists, engineers, and others keep extensive notes about the nature of the soils and about unique aspects of behavior of the soils. These notes include data on erosion, drought damage to specific crops, yield estimates, flooding, the functioning of septic tank disposal systems, and other factors affecting the productivity, potential, and limitations of the soils under various uses and management. In this way, field experience and measured data on soil properties and performance are used as a basis for predicting soil behavior.

Information in this section is useful in planning use and management of soils for crops and pasture, and rangeland, as sites for buildings, highways and other transportation systems, sanitary facilities, and parks and other recreation facilities, and for wildlife habitat. From the data presented, the potential of each soil for specified land uses can be determined, soil limitations to these land uses can be identified, and costly failures in houses and other structures, caused by unfavorable soil properties, can be avoided. A site where soil properties are favorable can be selected, or practices that will overcome the soil limitations can be planned.

Planners and others using the soil survey can evaluate the impact of specific land uses on the overall productivity of the survey area or other broad planning area and on the environment. Productivity and the environment are closely related to the nature of the soil. Plans should maintain or create a land-use pattern in harmony with the natural soil.

Contractors can find information that is useful in locating sources of sand and gravel, roadfill, and topsoil.

Other information indicates the presence of bedrock, wetness, or very firm soil horizons that cause difficulty in excavation.

Health officials, highway officials, engineers, and many other specialists also can find useful information in this soil survey. The safe disposal of wastes, for example, is closely related to properties of the soil. Pavements, sidewalks, campsites, playgrounds, and trees and shrubs are influenced by the nature of the soil.

Crops and pasture

Earl J. Bondy, conservation agronomist, Soil Conservation Service, helped prepare this section.

The major management concerns in the use of the soils for crops and pasture are described in this section. In addition, the crops or pasture plants best suited to the soil, including some not commonly grown in the survey area, are discussed; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops and hay and pasture plants are presented for each soil.

This section provides information about the overall agricultural potential of the survey area and about the management practices that are needed. The information is useful to equipment dealers, land improvement contractors, fertilizer companies, processing companies, planners, conservationists, and others. For each kind of soil, information about management is presented in the section "Soil maps for detailed planning." Planners of management systems for individual fields or farms should also consider the detailed information given in the description of each soil.

Approximately 35 percent of the acreage in Lyon County was used for harvested crops during the 10 years ending in 1976. During this period, about 33 percent of the cropland was in sorghum, 23 percent in wheat, 18 percent in soybeans, 15 percent in corn, and 11 percent in alfalfa, oats, barley, and rye.

The acreage of sorghum increased by 24 percent and the acreage of soybeans by 9 percent during this period. The acreage of all other crops decreased.

The Kenoma soil is used most extensively for crops in the county. Soils used less extensively are Martin, Ladysmith, Chase, Ivan, Reading, and Osage.

Erosion is the major hazard on about 75 percent of the cropland in Lyon County. Erosion is a hazard if the slope is more than 1 percent.

Loss of the surface layer through erosion is damaging for two reasons. First, productivity is reduced as the surface layer is lost and part of the subsoil is incorporated into the plow layer. Loss of the surface layer is especially damaging on soils that have a clayey subsoil, for example, Kenoma, Martin, and Ladysmith soils. Second, erosion results in sediment entering streams. Control of erosion minimizes the pollution of streams by sediment and improves the quality of water.

Erosion control practices are becoming more common in Lyon County. Erosion control provides a protective cover, reduces runoff, and increases infiltration. A cropping system that keeps a plant cover on the soil for extended periods reduces the risk of erosion and preserves the productive capacity of the soil.

Terraces and diversions reduce the length of slopes and thus reduce the rate of runoff and the hazard of erosion. They are most practical on deep, well-drained soils that have uniform regular slopes. Practically all of the soils in the county are suitable for terracing.

Contour tillage should generally be used in combination with terraces. Contour tillage is best suited to those soils that have smooth, uniform slopes and are suitable for terracing.

Leaving crop residue on the surface by minimum tillage or stubble mulching increases infiltration and reduces runoff and the hazard of water erosion. The extra cover is essential in controlling wind erosion.

Information on the design of erosion control practices is available in county offices of the Soil Conservation Service. The latest information and suggestions on growing crops can be obtained from the Cooperative Extension Service or the Soil Conservation Service.

Yields per acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 5. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors. Absence of an estimated yield indicates that the crop is not suited to or not commonly grown on the soil.

The estimated yields were based mainly on the experience and records of farmers, conservationists, and extension agents. Results of field trials and demonstrations and available yield data from nearby counties were also considered.

The yields were estimated assuming that the latest soil and crop management practices were used. Hay and pasture yields were estimated for the most productive varieties of grasses and legumes suited to the climate and the soil. A few farmers may be obtaining average yields higher than those shown in table 5.

The management needed to achieve the indicated yields of the various crops depends on the kind of soil and the crop. Such management provides drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate tillage practices, including time of tillage and seedbed preparation and tilling when soil moisture is favorable; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace ele-

ments for each crop; effective use of crop residues, barnyard manure, and green-manure crops; harvesting crops with the smallest possible loss; and timeliness of all fieldwork.

The estimated yields reflect the productive capacity of the soils for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 5 are grown in the survey area, but estimated yields are not included because the acreage of these crops is small. The local offices of the Soil Conservation Service and the Cooperative Extension Service can provide information about the management concerns and productivity of the soils for these crops.

Capability classes and subclasses

Capability classes and subclasses show, in a general way, the suitability of soils for most kinds of field crops. The soils are classed according to their limitations when they are used for field crops, the risk of damage when they are used, and the way they respond to treatment. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils; does not take into consideration possible but unlikely major reclamation projects; and does not apply to rice, cranberries, horticultural crops, or other crops that require special management. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for forest trees, or for engineering purposes.

In the capability system, all kinds of soil are grouped at three levels: capability class, subclass, and unit. The capability class and subclass levels are defined in the following paragraphs. A survey area may not have soils of all classes.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have few limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants, or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants, or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and landforms have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class; they are designated by adding a small letter, *e, w, s,* or *c,* to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w, s,* or *c* because the soils in class V are subject to little or no erosion, though they have other limitations that restrict their use to pasture, rangeland, woodland, wildlife habitat, or recreation.

The capability subclass is identified in the description of each soil mapping unit in the section "Soil maps for detailed planning."

Rangeland

Leonard J. Jurgens, range conservationist, Soil Conservation Service, helped prepare this section.

About 254,000 acres, or 45 percent, of Lyon County is rangeland that is used mainly for cattle. An additional 27,000 acres is pasture. Pasture and crop residue supplement the rangeland grazing. Most of the rangeland is in the Flint Hills.

The principal livestock enterprises are cow-calf operations and stocker-feeder and yearling programs. Also in the county are a number of feedlots ranging from small to large. Several meat packing plants, one with a nationwide distribution system, provide an excellent outlet for livestock produced in the county and surrounding area.

If well managed, practically all the soils in the county have the potential for producing high quality forage for grazing animals and rangeland wildlife. The soils, climate, and topography in Lyon County make these rangelands a natural resource that responds readily to well planned grazing management.

Where climate and topography are about the same, differences in the kind and amount of vegetation that rangeland can produce are related closely to the kind of soil. Effective management is based on the relationships among soils, vegetation, and water.

Table 6 shows, for each kind of soil, the name of the range site; the total annual production of vegetation in

favorable, normal, and unfavorable years; the characteristic vegetation; and the expected percentage of each species in the composition of the potential natural plant community. Soils not listed cannot support a natural plant community that is predominantly grasses, forbs, or shrubs suitable for grazing or browsing. The following are explanations of column headings in table 6.

A *range site* is a distinctive kind of rangeland that differs from other kinds of rangeland in its ability to produce a characteristic natural plant community. Soils that produce a similar kind, amount, and proportion of range plants are grouped into range sites. For those areas where the relationship between soils and vegetation has been established, range sites can be interpreted directly from the soil map. Properties that determine the capacity of the soil to supply moisture and plant nutrients have the greatest influence on the productivity of range plants. Soil reaction, salt content, and a seasonal high water table are also important.

Total production refers to the amount of vegetation that can be expected to grow annually on well managed rangeland that is supporting the potential natural plant community. It is expressed in pounds per acre of air-dry vegetation for favorable, normal, and unfavorable years. In a favorable year the amount and distribution of precipitation and the temperatures are such that growing conditions are substantially better than average; in a normal year these conditions are about average for the area; in an unfavorable year, growing conditions are well below average, generally because of low available soil moisture.

Dry weight refers to the total air-dry vegetation produced per acre each year by the potential natural plant community. Vegetation that is highly palatable to livestock and vegetation that is unpalatable are included. Some of the vegetation can also be grazed extensively by wildlife.

Characteristic species of grasses, grasslike plants, forbs, and shrubs that make up most of the potential natural plant community on each soil are listed by common name. Under *Composition*, the expected proportion of each species is presented as the percentage, in air-dry weight, of the total annual production of herbaceous and woody plants. The amount that can be used as forage depends on the kinds of grazing animals and on the grazing season. Generally all of the vegetation produced is not used.

Range management requires, in addition to knowledge of the kinds of soil and the potential natural plant community, an evaluation of the present condition of the range vegetation in relation to its potential. Range condition is determined by comparing the present plant community with the potential natural plant community on a particular range site. The more closely the existing community resembles the potential community, the better the range condition. The objective in range management is to control grazing so that the plants growing on a site are about the same in kind and amount as the potential natural plant community for that site. Such management generally results in the maximum production of vegetation, conservation of water, and control of erosion. Sometimes, however, a range condition somewhat below the potential meets grazing needs, provides wildlife habitat, and protects soil and water resources.

In Lyon County it is usually feasible to manage for excellent range condition. Good grazing management can restore the natural plant community, or the excellent range condition, on most of the rangeland in the county. On some poor quality rangeland and abandoned cropland, referred to as go-back land, seeding is needed to restore the potential natural plant community.

At the present time only about 10 percent of the rangeland in the county is producing its potential. About 70 percent can be restored to its production potential with improved grazing management and some supplemental practices. About 20 percent needs renovation or reestablishment.

Windbreaks and environmental plantings

Windbreaks are established to protect livestock, buildings, and yards from wind and snow. Windbreaks also help protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broad-leaved and coniferous species provide the most protection.

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. A healthy planting stock of suitable species planted properly on a well prepared site and maintained in good condition can insure a high degree of plant survival.

Table 7 shows the height that locally grown trees and shrubs are expected to reach on various kinds of soil in 20 years. The estimates in table 7, based on measurements and observation of established plantings that have been given adequate care, can be used as a guide in planning windbreaks and screens. Additional information about planning windbreaks and screens and the planting and care of trees can be obtained from local offices of the Soil Conservation Service or the Cooperative Extension Service or a nursery.

Engineering

This section provides information about the use of soils for building sites, sanitary facilities, construction material, and water management. Among those who can benefit from this information are engineers, landowners, community planners, town and city managers, land developers, builders, contractors, and farmers and ranchers.

The ratings in the engineering tables are based on test data and estimated data in the "Soil properties" section. The ratings were determined jointly by soil scientists and engineers of the Soil Conservation Service using known relationships between the soil properties and the behavior of soils in various engineering uses.

Among the soil properties and site conditions identified by a soil survey and used in determining the ratings in this section were grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock that is within 5 or 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure or aggregation, in-place soil density, and geologic origin of the soil material. Where pertinent, data about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations were also considered.

On the basis of information assembled about soil properties, ranges of values can be estimated for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, compressibility, slope stability, and other factors of expected soil behavior in engineering uses. As appropriate, these values can be applied to each major horizon of each soil or to the entire profile.

These factors of soil behavior affect construction and maintenance of roads, airport runways, pipelines, foundations for small buildings, ponds and small dams, irrigation projects, drainage systems, sewage and refuse disposal systems, and other engineering works. The ranges of values can be used to (1) select potential residential, commercial, industrial, and recreational uses; (2) make preliminary estimates pertinent to construction in a particular area; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for location of sanitary landfills, onsite sewage disposal systems, and other waste disposal facilities; (5) plan detailed onsite investigations of soils and geology; (6) find sources of gravel, sand, clay, and topsoil; (7) plan farm drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; (8) relate performance of structures already built to the properties of the kinds of soil on which they are built so that performance of similar structures on the same or a similar soil in other locations can be predicted; and (9) predict the trafficability of soils for cross-country movement of vehicles and construction equipment.

Data presented in this section are useful for land-use planning and for choosing alternative practices or general designs that will overcome unfavorable soil properties and minimize soil-related failures. Limitations to the use of these data, however, should be well understood. First, the data are generally not presented for soil material below a depth of 5 or 6 feet. Also, because of the scale of the detailed map in this soil survey, small areas of soils that differ from the dominant soil may be included in mapping. Thus, these data do not eliminate the need for onsite investigations, testing, and analysis by personnel having expertise in the specific use contemplated.

The information is presented mainly in tables. Table 8 shows, for each kind of soil, the degree and kind of limitations for building site development; table 9, for sanitary facilities; and table 11, for water management. Table 10 shows the suitability of each kind of soil as a source of construction materials.

The information in the tables, along with the soil map, the soil descriptions, and other data provided in this survey, can be used to make additional interpretations and to construct interpretive maps for specific uses of land.

Some of the terms used in this soil survey have a special meaning in soil science. Many of these terms are defined in the Glossary.

Building site development

The degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, and local roads and streets are indicated in table 8. A *slight* limitation indicates that soil properties generally are favorable for the specified use; any limitation is minor and easily overcome. A *moderate* limitation indicates that soil properties and site features are unfavorable for the specified use, but the limitations can be overcome or minimized by special planning and design. A *severe* limitation indicates that one or more soil properties or site features are so unfavorable or difficult to overcome that a major increase in construction effort, special design, or intensive maintenance is required. For some soils rated severe, such costly measures may not be feasible.

Shallow excavations are made for pipelines, sewerlines, communications and power transmission lines, basements, open ditches, and cemeteries. Such digging or trenching is influenced by soil wetness caused by a seasonal high water table; the texture and consistence of soils; the tendency of soils to cave in or slough; and the presence of very firm, dense soil layers, bedrock, or large stones. In addition, excavations are affected by slope of the soil and the probability of flooding. Ratings do not apply to soil horizons below a depth of 6 feet unless otherwise noted.

In the soil series descriptions, the consistence of each soil horizon is given, and the presence of very firm or extremely firm horizons, usually difficult to excavate, is indicated.

Dwellings and *small commercial buildings* referred to in table 8 are built on undisturbed soil and have foundation loads of a dwelling no more than three stories high. Separate ratings are made for small commercial buildings without basements and for dwellings with and without basements. For such structures, soils should be sufficiently stable that cracking or subsidence of the structure from settling or shear failure of the foundation does

not occur. These ratings were determined from estimates of the shear strength, compressibility, and shrink-swell potential of the soil. Soil texture, plasticity and in-place density, soil wetness, and depth to a seasonal high water table were also considered. Soil wetness and depth to a seasonal high water table indicate potential difficulty in providing adequate drainage for basements, lawns, and gardens. Depth to bedrock, slope, and large stones in or on the soil are also important considerations in the choice of sites for these structures and were considered in determining the ratings. Susceptibility to flooding is a serious hazard.

Local roads and streets referred to in table 8 have an all-weather surface that can carry light to medium traffic all year. They consist of a subgrade of the underlying soil material; a base of gravel, crushed rock fragments, or soil material stabilized with lime or cement; and a flexible or rigid surface, commonly asphalt or concrete. The roads are graded with soil material at hand, and most cuts and fills are less than 6 feet deep.

The load supporting capacity and the stability of the soil as well as the quantity and workability of fill material available are important in design and construction of roads and streets. The classifications of the soil and the soil texture, density, shrink-swell potential, and potential frost action are indicators of the traffic supporting capacity used in making the ratings. Soil wetness, flooding, slope, depth to hard rock or very compact layers, and content of large stones affect stability and ease of excavation.

Sanitary facilities

Favorable soil properties and site features are needed for proper functioning of septic tank absorption fields, sewage lagoons, and sanitary landfills. The nature of the soil is important in selecting sites for these facilities and in identifying limiting soil properties and site features to be considered in design and installation. Also, those soil properties that affect ease of excavation or installation of these facilities will be of interest to contractors and local officials. Table 9 shows the degree and kind of limitations of each soil for such uses and for use of the soil as daily cover for landfills. It is important to observe local ordinances and regulations.

If the degree of soil limitation is expressed as *slight*, soils are generally favorable for the specified use and limitations are minor and easily overcome; if *moderate*, soil properties or site features are unfavorable for the specified use, but limitations can be overcome by special planning and design; and if *severe*, soil properties or site features are so unfavorable or difficult to overcome that major soil reclamation, special designs, or intensive maintenance is required. Soil suitability is rated by the terms *good*, *fair*, or *poor*, which, respectively, mean about the same as the terms *slight*, *moderate*, and *severe*.

Septic tank absorption fields are subsurface systems of tile or perforated pipe that distribute effluent from a septic tank into the natural soil. Only the soil horizons between depths of 18 and 72 inches are evaluated for this use. The soil properties and site features considered are those that affect the absorption of the effluent and those that affect the construction of the system.

Properties and features that affect absorption of the effluent are permeability, depth to seasonal high water table, depth to bedrock, and susceptibility to flooding. Stones, boulders, and shallowness to bedrock interfere with installation. Excessive slope can cause lateral seepage and surfacing of the effluent. Also, soil erosion and soil slippage are hazards if absorption fields are installed on sloping soils.

In some soils, loose sand and gravel or fractured bedrock is less than 4 feet below the tile lines. In these soils the absorption field does not adequately filter the effluent, and ground water in the area may be contaminated.

On many of the soils that have moderate or severe limitations for use as septic tank absorption fields, a system to lower the seasonal water table can be installed or the size of the absorption field can be increased so that performance is satisfactory.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons have a nearly level floor and cut slopes or embankments of compacted soil material. Aerobic lagoons generally are designed to hold sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water. Soils that are very high in content of organic matter and those that have cobbles, stones, or boulders are not suitable. Unless the soil has very slow permeability, contamination of ground water is a hazard where the seasonal high water table is above the level of the lagoon floor. In soils where the water table is seasonally high, seepage of ground water into the lagoon can seriously reduce the lagoon's capacity for liquid waste. Slope, depth to bedrock, and susceptibility to flooding also affect the suitability of sites for sewage lagoons or the cost of construction. Shear strength and permeability of compacted soil material affect the performance of embankments.

Sanitary landfill is a method of disposing of solid waste by placing refuse in successive layers either in excavated trenches or on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil material. Landfill areas are subject to heavy vehicular traffic. Risk of polluting ground water and trafficability affect the suitability of a soil for this use. The best soils have a loamy or silty texture, have moderate to slow permeability, are deep to a seasonal water table, and are not subject to flooding. Clayey soils are likely to be sticky and difficult to spread. Sandy or gravelly soils generally have rapid permeability, which might allow nox-

ious liquids to contaminate ground water. Soil wetness can be a limitation, because operating heavy equipment on a wet soil is difficult. Seepage into the refuse increases the risk of pollution of ground water.

Ease of excavation affects the suitability of a soil for the trench type of landfill. A suitable soil is deep to bedrock and free of large stones and boulders. If the seasonal water table is high, water will seep into trenches.

Unless otherwise stated, the limitations in table 9 apply only to the soil material within a depth of about 6 feet. If the trench is deeper, a limitation of slight or moderate may not be valid. Site investigation is needed before a site is selected.

Daily cover for landfill should be soil that is easy to excavate and spread over the compacted fill in wet and dry periods. Soils that are loamy or silty and free of stones or boulders are better than other soils. Clayey soils may be sticky and difficult to spread; sandy soils may be subject to soil blowing.

The soils selected for final cover of landfills should be suitable for growing plants. Of all the horizons, the A horizon in most soils has the best workability, more organic matter, and the best potential for growing plants. Thus, for either the area- or trench-type landfill, stockpiling material from the A horizon for use as the surface layer of the final cover is desirable.

Where it is necessary to bring in soil material for daily or final cover, thickness of suitable soil material available and depth to a seasonal high water table in soils surrounding the sites should be evaluated. Other factors to be evaluated are those that affect reclamation of the borrow areas. These factors include slope, erodibility, and potential for plant growth.

Construction materials

The suitability of each soil as a source of roadfill, sand, gravel, and topsoil is indicated in table 10 by ratings of good, fair, or poor. The texture, thickness, and organic-matter content of each soil horizon are important factors in rating soils for use as construction materials. Each soil is evaluated to the depth observed, generally about 6 feet.

Roadfill is soil material used in embankments for roads. Soils are evaluated as a source of roadfill for low embankments, which generally are less than 6 feet high and less exacting in design than high embankments. The ratings reflect the ease of excavating and working the material and the expected performance of the material where it has been compacted and adequately drained. The performance of soil after it is stabilized with lime or cement is not considered in the ratings, but information about some of the soil properties that influence such performance is given in the descriptions of the soil series.

The ratings apply to the soil material between the A horizon and a depth of 5 to 6 feet. It is assumed that soil horizons will be mixed during excavation and spreading. Many soils have horizons of contrasting suitability within their profile. The estimated engineering properties in table 14 provide specific information about the nature of each horizon. This information can help determine the suitability of each horizon for roadfill.

Soils rated *good* are coarse grained. They have low shrink-swell potential and few cobbles and stones. They are at least moderately well drained and have slopes of 15 percent or less. Soils rated *fair* have a plasticity index of less than 15 and have other limiting features, such as moderate shrink-swell potential, moderately steep slopes, wetness, or many stones. If the thickness of suitable material is less than 3 feet, the entire soil is rated *poor*.

Sand and *gravel* are used in great quantities in many kinds of construction. The ratings in table 10 provide guidance as to where to look for probable sources and are based on the probability that soils in a given area contain sizable quantities of sand or gravel. A soil rated *good* or *fair* has a layer of suitable material at least 3 feet thick, the top of which is within a depth of 6 feet. Coarse fragments of soft bedrock material, such as shale and siltstone, are not considered to be sand and gravel. Fine-grained soils are not suitable sources of sand and gravel.

The ratings do not take into account depth to the water table or other factors that affect excavation of the material. Descriptions of grain size, kinds of minerals, reaction, and stratification are given in the soil series descriptions and in table 14.

Topsoil is used in areas where vegetation is to be established and maintained. Suitability is affected mainly by the ease of working and spreading the soil material in preparing a seedbed and by the ability of the soil material to support plantlife. Also considered is the damage that can result at the area from which the topsoil is taken.

The ease of excavation is influenced by the thickness of suitable material, wetness, slope, and amount of stones. The ability of the soil to support plantlife is determined by texture, structure, and the amount of soluble salts or toxic substances. Organic matter in the A1 or Ap horizon greatly increases the absorption and retention of moisture and nutrients. Therefore, the soil material from these horizons should be carefully preserved for later use.

Soils rated *good* have at least 16 inches of friable loamy material at their surface. They are free of stones and cobbles, are low in content of gravel, and have gentle slopes. They are low in soluble salts that can limit or prevent plant growth. They are naturally fertile or respond well to fertilizer. They are not so wet that excavation is difficult during most of the year.

Soils rated *fair* are loose sandy soils or firm loamy or clayey soils in which the suitable material is only 8 to 16 inches thick or soils that have appreciable amounts of gravel, stones, or soluble salt.

Soils rated *poor* are very sandy soils and very firm clayey soils; soils with suitable layers less than 8 inches thick; soils having large amounts of gravel, stones, or soluble salt; steep soils; and poorly drained soils.

Although a rating of *good* is not based entirely on high content of organic matter, a surface horizon is generally preferred for topsoil because of its organic-matter content. This horizon is designated as A1 or Ap in the soil series descriptions. The absorption and retention of moisture and nutrients for plant growth are greatly increased by organic matter.

Water management

Many soil properties and site features that affect water management practices have been identified in this soil survey. In table 11 soil and site features that affect use are indicated for each kind of soil. This information is significant in planning, installing, and maintaining water control structures.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have a low seepage potential, which is determined by permeability and the depth to fractured or permeable bedrock or other permeable material.

Embankments, dikes, and levees require soil material that is resistant to seepage, erosion, and piping and has favorable stability, shrink-swell potential, shear strength, and compaction characteristics. Large stones and organic matter in a soil downgrade the suitability of a soil for use in embankments, dikes, and levees.

Drainage of soil is affected by such soil properties as permeability; texture; depth to bedrock, hardpan, or other layers that affect the rate of water movement; depth to the water table; slope; stability of ditchbanks; susceptibility to flooding; salinity and alkalinity; and availability of outlets for drainage.

Irrigation is affected by such features as slope, susceptibility to flooding, hazards of water erosion and soil blowing, texture, presence of salts and alkali, depth of root zone, rate of water intake at the surface, permeability of the soil below the surface layer, available water capacity, need for drainage, and depth to the water table.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to intercept runoff. They allow water to soak into the soil or flow slowly to an outlet. Features that affect suitability of a soil for terraces are uniformity and steepness of slope; depth to bedrock, hardpan, or other unfavorable material; large stones; permeability; ease of establishing vegetation; and resistance to water erosion, soil blowing, soil slipping, and piping.

Grassed waterways are constructed to channel runoff to outlets at a nonerosive velocity. Features that affect the use of soils for waterways are slope, permeability, erodibility, wetness, and suitability for permanent vegetation.

Recreation

Robert J. Higgins, biologist, Soil Conservation Service, helped prepare this section.

Several watershed lakes and farm ponds in Lyon County and the Neosho and Cottonwood Rivers provide opportunities for water-based recreation on privately owned lands. Several large reservoirs in surrounding counties provide public lands for recreation.

The soils of the survey area are rated in table 12 according to limitations that affect their suitability for recreation uses. The ratings are based on such restrictive soil features as flooding, wetness, slope, and texture of the surface layer. Not considered in these ratings, but important in evaluating a site, are location and accessibility of the area, size and shape of the area and its scenic quality, the ability of the soil to support vegetation, access to water, potential water impoundment sites available, and either access to public sewerlines or suitability of the soil for septic tanks or sewage lagoons. Soils subject to flooding are limited, in varying degree, for recreation use by the duration and intensity of flooding and the season when flooding occurs. Onsite assessment of height, duration, intensity, and frequency of flooding is essential in planning recreation facilities.

The degree of the limitation of the soils is expressed as slight, moderate, or severe. *Slight* means that the soil properties are generally favorable and that the limitations are minor and easily overcome. *Moderate* means that the limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 12 can be supplemented by information in other parts of this survey. Especially helpful are interpretations for septic tank absorption fields, given in table 9, and interpretations for dwellings without basements and for local roads and streets, given in table 8.

Camp areas require such site preparation as shaping and leveling for tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils for this use have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and

stones or boulders can greatly increase the cost of constructing camping sites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for use as picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that will increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones or boulders, is firm after rains, and is not dusty when dry. If shaping is required to obtain a uniform grade, the depth of the soil over bedrock or hardpan should be enough to allow necessary grading.

Paths and trails for walking, horseback riding, bicycling, and other uses should require little or no cutting and filling. The best soils for this use are those that are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once during the annual period of use. They should have moderate slopes and have few or no stones or boulders on the surface.

Wildlife habitat

Robert J. Higgins, biologist, Soil Conservation Service, helped prepare this section.

The main game species in Lyon County are the bobwhite quail, mourning dove, several species of waterfowl, cottontail, fox squirrel, and whitetail deer.

Nongame species of wildlife are numerous because of the diverse habitat types. Cropland, woodland, and grassland are interspersed throughout the county creating the desirable edge effect that attracts many species.

Furbearers are common along the Neosho and Cottonwood Rivers and their tributaries. Trapping is done on a limited basis.

Lakes, ponds, and streams provide good to excellent fishing. Species commonly taken in the county are channel cat, bullhead and flathead catfish, bass, bluegill, sunfish, and carp.

Soils directly affect the kind and amount of vegetation that is available to wildlife as food and cover, and they affect the construction of water impoundments. The kind and abundance of wildlife that populate an area depend largely on the amount and distribution of food, cover, and water. If any one of these elements is missing, is inadequate, or is inaccessible, wildlife either are scarce or do not inhabit the area.

If the soils have the potential, wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by helping the natural establishment of desirable plants.

In table 13, the soils in the survey area are rated according to their potential to support the main kinds of wildlife habitat in the area. This information can be used in planning for parks, wildlife refuges, nature study areas, and other developments for wildlife; selecting areas that are suitable for wildlife; selecting soils that are suitable for creating, improving, or maintaining specific elements of wildlife habitat; and determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* means that the element of wildlife habitat or the kind of habitat is easily created, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected if the soil is used for the designated purpose. A rating of *fair* means that the element of wildlife habitat or kind of habitat can be created, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* means that limitations are severe for the designated element or kind of wildlife habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* means that restrictions for the element of wildlife habitat or kind of wildlife are very severe, and that unsatisfactory results can be expected. Wildlife habitat is impractical or even impossible to create, improve, or maintain on soils having such a rating.

The elements of wildlife habitat are briefly described in the following paragraphs.

Grain and seed crops are seed-producing annuals used by wildlife. The major soil properties that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, wheat, soybeans, and grain sorghum.

Grasses and legumes are domestic perennial grasses and herbaceous legumes that are planted for wildlife food and cover. Major soil properties that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are fescue, bromegrass, clover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds, that provide food and cover for wildlife. Major soil properties that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are bluestem, switchgrass, Indiangrass, goldenrod, ragweed, native legumes, wheatgrass, and grama.

Hardwood trees and the associated woody understory provide cover for wildlife and produce nuts, seeds, fruit, buds, catkins, twigs, bark, or foliage that wildlife eat. Major soil properties that affect growth of hardwood trees and shrubs are depth of the root zone, available water capacity, and wetness. Examples of native plants are oak, cottonwood, black cherry, black walnut, hackberry, willow, green ash, hawthorn, hickory, and mulberry. Examples of fruit-producing shrubs that are commercially available and suitable for planting on soils rated *good* are Russian-olive, autumn-olive, plum, fragrant sumac, and crabapple.

Coniferous plants are cone-bearing trees, shrubs, or ground cover plants that furnish habitat or supply food in the form of browse, seeds, or fruitlike cones. Soil properties that have a major effect on the growth of coniferous plants are depth of the root zone, available water capacity, and wetness. Examples of coniferous plants are redcedar, pine, and spruce.

Shrubs are bushy woody plants that produce fruit, seed, buds, twigs, bark, or foliage used by wildlife or that provide cover and shade for some species of wildlife. Major soil properties that affect the growth of shrubs are depth of the root zone, available water capacity, salinity, and moisture. Examples of shrubs are dogwood, gooseberry, blackberry, buckbrush, prairie rose and sumac.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites, exclusive of submerged or floating aquatics. They produce food or cover for wildlife that use wetland as habitat. Major soil properties affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are smartweed, cattails, saltgrass, indigobush, buttonbush, prairie cordgrass, and rushes, sedges, and reeds.

Shallow water areas are bodies of water that have an average depth of less than 5 feet and that are useful to wildlife. They can be naturally wet areas, or they can be created by dams or levees or by water-control structures in marshes or streams. Major soil properties affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. The availability of a dependable water supply is important if water areas are to be developed. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The kinds of wildlife habitat are briefly described in the following paragraphs.

Openland habitat consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The kinds of wildlife attracted to these areas include bobwhite quail, meadowlark, field sparrow, cottontail rabbit, and red fox.

Woodland habitat consists of areas of hardwoods or conifers, or a mixture of both, and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include owls, thrushes, woodpeckers, squirrels, opossum, raccoon, and whitetail deer.

Rangeland habitat consists of areas of wild herbaceous plants and shrubs. Wildlife attracted to rangeland include coyotes, badgers, jack rabbits, hawks, dickcissels, killdeer, and meadowlark.

The right location and a plant cover the soil can support must be considered in developing specific habitat for wildlife. Onsite technical assistance in planning wildlife areas and in determining suitable species of vegetation for planting can be obtained from the Soil Conservation Service, the Kansas Fish and Game Commission, and the Kansas Extension Service.

Soil properties

Extensive data about soil properties are summarized on the following pages. The two main sources of data are the many thousands of soil borings made during the course of the survey and the laboratory analyses of selected soil samples from typical profiles.

In making soil borings during field mapping, soil scientists can identify several important soil properties. They note the seasonal soil moisture condition or the presence of free water and its depth. For each horizon in the profile, they note the thickness and color of the soil material; the texture, or amount of clay, silt, sand, and gravel or other coarse fragments; the structure, or the natural pattern of cracks and pores in the undisturbed soil; and the consistence of the soil material in place under the existing soil moisture conditions. They record the depth of plant roots, determine the pH or reaction of the soil, and identify any free carbonates.

Samples of soil material are analyzed in the laboratory to verify the field estimates of soil properties and to determine all major properties of key soils, especially properties that cannot be estimated accurately by field observation. Laboratory analyses are not conducted for all soil series in the survey area, but laboratory data for many soil series not tested are available from nearby survey areas.

The available field and laboratory data are summarized in tables. The tables give the estimated range of engineering properties, the engineering classifications, and the physical and chemical properties of each major horizon of each soil in the survey area. They also present data about pertinent soil and water features.

Engineering properties

Table 14 gives estimates of engineering properties and classifications for the major horizons of each soil in the survey area.

Most soils have, within the upper 5 or 6 feet, horizons of contrasting properties. Table 14 gives information for each of these contrasting horizons in a typical profile.

Depth to the upper and lower boundaries of each horizon is indicated. More information about the range in depth and about other properties in each horizon is given for each soil series in the section "Soil series and morphology."

Texture is described in table 14 in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in soil material that is less than 2 millimeters in diameter. "Loam," for example, is soil material that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If a soil contains gravel or other particles coarser than sand, an appropriate modifier is added, for example, "gravelly loam." Other texture terms are defined in the Glossary.

The two systems commonly used in classifying soils for engineering use are the Unified Soil Classification System (Unified) (*2*) and the system adopted by the American Association of State Highway and Transportation Officials (AASHTO) (*1*).

The *Unified* system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter, plasticity index, liquid limit, and organic-matter content. Soils are grouped into 15 classes—eight classes of coarse-grained soils, identified as GW, GP, GM, GC, SW, SP, SM, and SC; six classes of fine-grained soils, identified as ML, CL, OL, MH, CH, and OH; and one class of highly organic soils, identified as Pt. Soils on the borderline between two classes have a dual classification symbol, for example, CL-ML.

The *AASHTO* system classifies soils according to those properties that affect their use in highway construction and maintenance. In this system a mineral soil is classified in one of seven basic groups ranging from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines. At the other extreme, in group A-7, are fine-grained soils. Highly organic soils are classified in group A-8 on the basis of visual inspection.

When laboratory data are available, the A-1, A-2, and A-7 groups are further classified as follows: A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, and A-7-6. As an additional refinement, the desirability of soils as subgrade material can be indicated by a group index number. These numbers range from 0 for the best subgrade material to 20 or higher for the poorest. The estimated classification, without group index numbers, is given in table 14. Also in table 14 the percentage, by weight, of rock fragments more than 3 inches in diameter is estimated for each major horizon. These estimates are determined mainly by observing volume percentage in the field and then converting that, by formula, to weight percentage.

Percentage of the soil material less than 3 inches in diameter that passes each of four sieves (U.S. standard) is estimated for each major horizon. The estimates are based on tests of soils that were sampled in the survey area and in nearby areas and on field estimates from many borings made during the survey.

Liquid limit and *plasticity index* indicate the effect of water on the strength and consistence of soil. These indexes are used in both the Unified and AASHTO soil classification systems. They are also used as indicators in making general predictions of soil behavior. Range in liquid limit and plasticity index is estimated on the basis of test data from the survey area or from nearby areas and on observations of the many soil borings made during the survey.

In some surveys, the estimates are rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterburg limits extend a marginal amount across classification boundaries (1 or 2 percent), the classification in the marginal zone is omitted.

Physical and chemical properties

Table 15 shows estimated values for several soil characteristics and features that affect behavior of soils in engineering uses. These estimates are given for each major horizon, at the depths indicated, in the typical pedon of each soil. The estimates are based on field observations and on test data for these and similar soils.

Permeability is estimated on the basis of known relationships among the soil characteristics observed in the field—particularly soil structure, porosity, and gradation or texture—that influence the downward movement of water in the soil. The estimates are for vertical water movement when the soil is saturated. Not considered in the estimates is lateral seepage or such transient soil features as plowpans and surface crusts. Permeability of the soil is an important factor to be considered in planning and designing drainage systems, in evaluating the potential of soils for septic tank systems and other waste disposal systems, and in many other aspects of land use and management.

Available water capacity is rated on the basis of soil characteristics that influence the ability of the soil to hold water and make it available to plants. Important characteristics are content of organic matter, soil texture, and soil structure. Shallow-rooted plants are not likely to use the available water from the deeper soil horizons. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design of irrigation systems.

Soil reaction is expressed as a range in pH values. The range in pH of each major horizon is based on many field checks. For many soils, the values have been verified by laboratory analyses. Soil reaction is important in selecting the crops, ornamental plants, or other plants to

be grown; in evaluating soil amendments for fertility and stabilization; and in evaluating the corrosivity of soils.

Shrink-swell potential depends mainly on the amount and kind of clay in the soil. Laboratory measurements of the swelling of undisturbed clods were made for many soils. For others the swelling was estimated on the basis of the kind and amount of clay in the soil and on measurements of similar soils. The size of the load and the magnitude of the change in soil moisture content also influence the swelling of soils. Shrinking and swelling of some soils can cause damage to building foundations, basement walls, roads, and other structures unless special designs are used. A high shrink-swell potential indicates that special design and added expense may be required if the planned use of the soil will not tolerate large volume changes.

Erosion factors are used to predict the erodibility of a soil and its tolerance to erosion in relation to specific kinds of land use and treatment. The soil erodibility factor (K) is a measure of the susceptibility of the soil to erosion by water. Soils having the highest K values are the most erodible. K values range from 0.10 to 0.64. To estimate annual soil loss per acre, the K value of a soil is modified by factors representing plant cover, grade and length of slope, management practices, and climate. The soil-loss tolerance factor (T) is the maximum rate of soil erosion, whether from rainfall or soil blowing, that can occur without reducing crop production or environmental quality. The rate is expressed in tons of soil loss per acre per year.

Wind erodibility groups are made up of soils that have similar properties that affect their resistance to soil blowing if cultivated. The groups are used to predict the susceptibility of soil to blowing and the amount of soil lost as a result of blowing. Soils are grouped according to the following distinctions:

1. Sands, coarse sands, fine sands, and very fine sands. These soils are extremely erodible, so vegetation is difficult to establish. They are generally not suitable for crops.

2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible, but crops can be grown if intensive measures to control soil blowing are used.

3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible, but crops can be grown if intensive measures to control soil blowing are used.

4L. Calcareous loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible, but crops can be grown if intensive measures to control soil blowing are used.

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible, but crops can be grown if measures to control soil blowing are used.

5. Loamy soils that are less than 18 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible, but crops can be grown if measures to control soil blowing are used.

6. Loamy soils that are 18 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible, and crops can easily be grown.

7. Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible, and crops can easily be grown.

8. Stony or gravelly soils and other soils not subject to soil blowing.

Soil and water features

Table 16 contains information helpful in planning land uses and engineering projects that are likely to be affected by soil and water features.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are placed in one of four groups on the basis of the intake of water after the soils have been wetted and have received precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist chiefly of deep, well drained to excessively drained sands or gravels. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils that have a layer that impedes the downward movement of water or soils that have moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clay soils that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Flooding is the temporary covering of soil with water from overflowing streams, with runoff from adjacent slopes, and by tides. Water standing for short periods after rains or after snow melts is not considered flooding, nor is water in swamps and marshes. Flooding is rated in general terms that describe the frequency and duration

of flooding and the time of year when flooding is most likely. The ratings are based on evidence in the soil profile of the effects of flooding, namely thin strata of gravel, sand, silt, or, in places, clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive soil horizons that form in soils of the area that are not subject to flooding. The ratings are also based on local information about floodwater levels in the area and the extent of flooding; and on information that relates the position of each soil on the landscape to historic floods.

The generalized description of flood hazards is of value in land-use planning and provides a valid basis for land-use restrictions. The soil data are less specific, however, than those provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table is the highest level of a saturated zone more than 6 inches thick for a continuous period of more than 2 weeks during most years. The depth to a seasonal high water table applies to undrained soils. Estimates are based mainly on the relationship between grayish colors or mottles in the soil and the depth to free water observed in many borings made during the course of the soil survey. Indicated in table 16 are the depth to the seasonal high water table; the kind of water table, that is, perched, artesian, or apparent; and the months of the year that the water table commonly is high. Only saturated zones above a depth of 5 or 6 feet are indicated.

Information about the seasonal high water table helps in assessing the need for specially designed foundations, the need for specific kinds of drainage systems, and the need for footing drains to insure dry basements. Such information is also needed to decide whether or not construction of basements is feasible and to determine how septic tank absorption fields and other underground installations will function. Also, a seasonal high water table affects ease of excavation.

Depth to bedrock is shown for all soils that are underlain by bedrock at a depth of 5 to 6 feet or less. For many soils, the limited depth to bedrock is a part of the definition of the soil series. The depths shown are based on measurements made in many soil borings and on other observations during the mapping of the soils. The kind of bedrock and its hardness as related to ease of excavation is also shown. Rippable bedrock can be excavated with a single-tooth ripping attachment on a 200-horsepower tractor, but hard bedrock generally requires blasting.

Risk of corrosion pertains to potential soil-induced chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to soil moisture, particle-size distribution, total acidity, and electrical conductivity of the soil material. The rate of corrosion of concrete is based mainly on the sulfate content, texture, and acidity of the soil. Protective measures for steel or more resistant concrete help to avoid or minimize damage resulting from the corrosion. Uncoated steel intersecting soil boundaries or soil horizons is more susceptible to corrosion than an installation that is entirely within one kind of soil or within one soil horizon.

Classification of the soils

The system of soil classification currently used was adopted by the National Cooperative Soil Survey in 1965. Readers interested in further details about the system should refer to "Soil taxonomy" (*4*).

The system of classification has six categories. Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. In this system the classification is based on the different soil properties that can be observed in the field or those that can be inferred either from other properties that are observable in the field or from the combined data of soil science and other disciplines. The properties selected for the higher categories are the result of soil genesis or of factors that affect soil genesis. In table 17, the soils of the survey area are classified according to the system. Categories of the system are discussed in the following paragraphs.

ORDER. Ten soil orders are recognized as classes in the system. The properties used to differentiate among orders are those that reflect the kind and degree of dominant soil-forming processes that have taken place. Each order is identified by a word ending in *sol*. An example is Mollisol.

SUBORDER. Each order is divided into suborders based primarily on properties that influence soil genesis and are important to plant growth or that are selected to reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Udoll (*Ud*, meaning humid, plus *oll*, from Mollisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of expression of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and a prefix that suggests something about the properties of the soil. An example is Argiudolls (*Argi*, meaning argillic horizons, plus *udoll*, the suborder of Mollisols that have an udic moisture regime).

SUBGROUP. Each great group may be divided into three subgroups: the central (typic) concept of the great groups, which is not necessarily the most extensive subgroup; the intergrades, or transitional forms to other orders, suborders, or great groups; and the extragrades, which have some properties that are representative of the great groups but do not indicate transitions to any other known kind of soil. Each subgroup is identified by

one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that is thought to typify the great group. An example is Typic Argiudolls.

FAMILY. Families are established within a subgroup on the basis of similar physical and chemical properties that affect management. Among the properties considered in horizons of major biological activity below plow depth are particle-size distribution, mineral content, temperature regime, thickness of the soil penetrable by roots, consistence, moisture equivalent, soil slope, and permanent cracks. A family name consists of the name of a subgroup and a series of adjectives. The adjectives are the class names for the soil properties used as family differentiae. An example is fine-silty, mixed, mesic, Typic Argiudolls.

SERIES. The series consists of soils that formed in a particular kind of material and have horizons that, except for texture of the surface soil or of the underlying substratum, are similar in differentiating characteristics and in arrangement in the soil profile. Among these characteristics are color, texture, structure, reaction, consistence, and mineral and chemical composition.

Soil series and morphology

In this section, each soil series recognized in the survey area is described in detail. The descriptions are arranged in alphabetic order by series name.

Characteristics of the soil and the material in which it formed are discussed for each series. The soil is then compared to similar soils and to nearby soils of other series. Then a pedon, a small three-dimensional area of soil that is typical of the soil series in the survey area, is described. The detailed descriptions of each soil horizon follow standards in the Soil Survey Manual (*3*). Unless otherwise noted, matrix colors described are for dry soil.

Following the pedon description is the range of important characteristics of the soil series in this survey area. Phases, or mapping units, of each soil series are described in the section "Soil maps for detailed planning."

Bates series

The Bates series consists of moderately deep, well drained, moderately permeable soils on uplands. These soils formed in material weathered from sandstone and silty or sandy shale. Slopes range from 3 to 8 percent.

Bates soils are similar to Collinsville soils and are commonly adjacent to Elmont and Kenoma soils. Collinsville soils are shallow over sandstone. Elmont and Kenoma soils are deep over shale. Elmont soils occur on foot slopes below Bates soils, and Kenoma soils are on ridgetops.

Typical pedon in an area of Bates loam, 3 to 6 percent slopes, 2,100 feet east and 50 feet north of southwest corner sec. 22, T. 21 S., R. 11 E.

A1—0 to 9 inches; dark grayish brown (10YR 4/2) loam, very dark brown (10YR 2/2) moist; moderate fine and medium granular structure; slightly hard, friable; many fine roots; medium acid; gradual smooth boundary.

B1—9 to 17 inches; brown (10YR 4/3) loam, dark brown (10YR 3/3) moist; moderate medium granular structure; slightly hard, friable; many fine roots; 5 percent sandstone pebbles; medium acid; gradual smooth boundary.

B2t—17 to 24 inches; dark brown (10YR 4/3) clay loam, dark brown (10YR 3/3) moist; moderate medium subangular blocky structure; hard, firm; few fine roots; few thin discontinuous clay films on many ped faces; 5 percent small soft sandstone fragments; medium acid; gradual smooth boundary.

B3—24 to 34 inches; yellowish brown (10YR 5/4) clay loam, dark yellowish brown (10YR 4/4) moist; coarse distinct grayish brown (10YR 5/2) and strong brown (7.5YR 5/6) mottles; weak medium subangular blocky structure; hard, firm; few small hard black concretions in lower part; 10 percent small soft sandstone fragments; medium acid; gradual boundary.

R—34 inches; yellowish brown (10YR 5/6) fine grained acid sandstone containing thin band of acid sandy shale.

Thickness of the solum ranges from 20 to 40 inches and coincides with the depth to sandstone. The mollic epipedon is 8 to 24 inches thick. Reaction throughout the profile ranges from slightly acid to strongly acid.

The A horizon has hue of 10YR, value of 3 to 5 (2 or 3 moist), and chroma of 2 or 3. It is dominantly loam, but the range includes silt loam.

The B1 horizon has hue of 10YR or 7.5YR, value of 4 or 5 (3 or 4 moist), and chroma of 2 or 3. It is loam or clay loam. The B2 horizon has hue or 10YR and 7.5YR, value of 4 to 6 (3 to 5 moist), and chroma of 3 to 6. It is loam, sandy clay loam, or clay loam. The B3 horizon has hue of 10YR or 7.5YR, value of 5 to 7 (4 or 5 moist), and chroma of 4 to 6. It is loam, sandy clay loam, or clay loam.

Chase series

The Chase series consists of deep, moderately well drained, slowly permeable soils on low stream terraces of the larger valleys. These soils formed in loamy and clayey alluvial sediments. The slope is 0 to 2 percent.

Chase soils are commonly adjacent to Martin, Osage, and Reading soils. Martin soils formed in material weathered from shale. They are on uplands. The poorly

drained Osage soils have a silty clay A horizon. They are on flood plains. The well drained Reading soils have a silty clay loam B2t horizon. They occupy slightly higher positions on stream terraces than Chase soils.

Typical pedon in an area of Chase silty clay loam, 1,860 feet east of northwest corner sec. 24, T. 18 S., R. 10 E.

Ap—0 to 9 inches; dark gray (10YR 4/1) silty clay loam, black (10YR 2/1) moist; weak medium and fine granular structure; slightly hard, friable; few fine wormholes and worm casts; slightly acid; abrupt smooth boundary.

A12—9 to 17 inches; dark gray (10YR 4/1) silty clay loam, black (10YR 2/1) moist; moderate fine and medium granular structure; slightly hard, friable; few fine wormholes and worm casts; slightly acid; gradual smooth boundary.

B1—17 to 25 inches; very dark gray (10YR 3/1) silty clay loam, black (10YR 2/1) moist; moderate fine and medium subangular blocky structure; hard, firm; few shiny surfaces; few wormholes and worm casts; slightly acid; gradual smooth boundary.

B2t—25 to 46 inches; dark gray (10YR 4/1) silty clay, black (10YR 2/1) moist; moderate medium blocky structure; very hard, very firm; shiny surfaces on most surfaces of peds; neutral; gradual smooth boundary.

C—46 to 60 inches; gray (10YR 5/1) silty clay loam, very dark grayish brown (10YR 3/2) moist; few fine faint yellowish brown (10YR 5/6) mottles; weak medium blocky structure; hard, firm; neutral.

Thickness of the solum ranges from 36 to 60 inches. Thickness of the mollic epipedon is more than 36 inches. Chase soils are medium acid to neutral in the A horizon and upper part of the B horizon and medium acid to mildly alkaline in the lower part.

The A horizon has hue of 10YR, value of 3 to 5 (2 or 3 moist), and chroma of 1 or 2. It is dominantly silty clay loam, but the range includes silt loam.

The B horizon has hue of 10YR, value of 3 to 5 (2 or 3 moist), and chroma of 1 or 2.

The C horizon has hue of 10YR, value of 3 to 5 (2 or 3 moist), and chroma of 1 or 2. It is silty clay loam or silty clay. The depth to faint yellowish brown mottles ranges from 30 to 60 inches.

Clime series

The Clime series consists of moderately deep, moderately well drained, slowly permeable soils on uplands. These soils formed in material weathered from calcareous shale. Slopes range from 3 to 20 percent.

Clime soils are similar to Zaar soils and are commonly adjacent to Martin and Sogn soils. Zaar and Martin soils are deep. Martin soils occur on foot slopes below Clime soils. Sogn soils are shallow. They are above Clime soils.

Typical pedon in an area of Clime silty clay, 3 to 7 percent slopes, 1,000 feet west and 50 feet south of northeast corner sec. 30, T. 20 S., R. 10 E.

A1—0 to 8 inches; dark grayish brown (10YR 4/2) silty clay, very dark brown (10YR 2/2) moist; moderate and strong fine granular structure; hard, firm; many roots; slight effervescence; moderately alkaline; clear smooth boundary.

B2—8 to l9 inches; grayish brown (10YR 5/2) silty clay, very dark grayish brown (10YR 3/2) moist; moderate medium and fine subangular blocky structure; very hard, very firm; few roots; strong effervescence; moderately alkaline; clear smooth boundary.

C1—19 to 34 inches; light olive gray (5Y 6/2) silty clay, olive gray (5Y 4/2) moist; massive; very hard, very firm; 15 percent shale fragments; strong effervescence; moderately alkaline; gradual smooth boundary.

Cr2—34 to 50 inches; light gray (5Y 7/2) consolidated calcareous clay shale, olive gray (5Y 5/2) moist.

Thickness of the solum ranges from 12 to 24 inches. The depth to shale ranges from 20 to 40 inches. Free carbonates are usually throughout the soil mass, but in some pedons there are no free carbonates within the upper 10 inches.

The A1 horizon has hue of 10YR or 2.5Y, value of 3 to 5 (2 or 3 moist), and chroma or 1 or 2. It is dominantly silty clay, but the range includes silty clay loam.

The B2 horizon has hue of 10YR or 2.5Y, value of 4 or 5 (3 or 4 moist), and chroma of 1 to 3. It is silty clay or silty clay loam.

The C horizon has hue of 10YR, 2.5Y or 5Y, value of 5 to 7 (4 to 6 moist), and chroma of 2 to 4.

Collinsville series

The Collinsville series consists of shallow, well drained, moderately rapidly permeable soils on uplands. These soils formed in material weathered from sandstone. Slopes range from 3 to 15 percent.

Collinsville soils are similar to Vinland soils and are commonly adjacent to Bates and Elmont soils. Vinland soils have shale parent material. Bates and Elmont soils have a B2t horizon and are deeper than Collinsville soils. Bates soils are higher in the landscape than Collinsville soils. Elmont soils are on foot slopes.

The Collinsville soils in this county are mapped only with Bates soils.

Typical pedon of Collinsville fine sandy loam in an area of Bates-Collinsville complex, 3 to 15 percent slopes, 50 feet north and 900 feet west of southeast corner sec. 22, T. 21 S., R. 11 E.

A1—0 to 7 inches; dark grayish brown (10YR 4/2) fine sandy loam, very dark grayish brown (10YR 3/2) moist; moderate medium granular structure; slightly hard, very friable; many roots; 10 percent small sandstone fragments; medium acid; gradual wavy boundary.

C—7 to 11 inches; brown (10YR 4/3) gravelly fine sandy loam, dark brown (10YR 3/3) moist; massive; slightly hard, friable; horizon is 35 percent sandstone fragments; medium acid; abrupt wavy boundary.

R—11 inches; light yellowish brown (10YR 6/4) indurated sandstone; extremely hard, fractured in places with small amount of soil material in crevices.

The depth to bedrock ranges from 4 to 20 inches. The A horizon has hue of 10YR, value of 3 to 5 (2 to 3 moist), and chroma of 2 and 3. It is dominantly fine sandy loam, but the range includes loam. Reaction ranges from strongly acid to slightly acid.

The C horizon has hue of 10YR or 7.5YR, value of 4 or 5 (3 to 4 moist), and chroma of 2 or 3. It is fine sandy loam or loam. In places the bedrock is fractured sandstone. The A and C horizons are commonly 5 to 50 percent sandstone fragments.

Dwight series

The Dwight series consists of deep, moderately well drained, very slowly permeable soils on uplands. These soils formed in old clayey sediments derived from shale. Slopes are 0 to 2 percent.

Dwight soils are similar to Labette and Ladysmith soils and are commonly adjacent to Labette soils. Labette and Ladysmith soils lack a natric horizon and have a thicker A horizon than Dwight soils. Labette and Dwight soils are on similar landscapes. Ladysmith soils are on ridgetops.

The Dwight soils in this county are mapped only with Labette soils.

Typical pedon of Dwight silt loam in an area of Labette-Dwight complex, 0 to 2 percent slopes, 50 feet east and 1,320 feet south of northwest corner sec. 13, T. 16 S., R. 10 E.

A1—0 to 4 inches; dark gray (10YR 4/1) silt loam, very dark brown (10YR 2/2) moist; weak platy structure in upper inch and weak fine granular structure below; slightly hard, friable; abundant fine roots; slightly acid; abrupt smooth boundary.

B21t—4 to 20 inches; very dark grayish brown (10YR 3/2) silty clay, very dark brown (10YR 2/2) moist; moderate medium columnar structure parting to weak fine blocky when moist; extremely hard, extremely firm; common fine roots flattened along ped faces; slightly acid; clear smooth boundary.

B22t—20 to 32 inches; brown (10YR 5/3) silty clay, very dark brown (10YR 4/3) moist; weak medium and coarse blocky structure; extremely hard, extremely firm; few fine roots; mildly alkaline; gradual smooth boundary.

B3—32 to 49 inches; brown (10YR 5/3) silty clay, brown (10YR 4/3) moist; few fine and medium distinct reddish yellow (7.5YR 6/6) and light gray (10YR 7/2) mottles; weak fine and medium blocky structure; very hard, very firm; moderately alkaline; abrupt boundary.

IIR—49 inches; cherty limestone bedrock.

Thickness of the solum ranges from 30 to 55 inches. The depth to limestone or shale is more than 40 inches. Lime is in the lower part of the solum and in the C horizon.

The A horizon has hue of 10YR, value of 4 or 5 (2 or 3 moist), and chroma of 1 or 2. It is dominantly silt loam, but the range includes silty clay loam. Reaction is medium acid to neutral.

The B2t horizon has hue of 10YR, value of 4 or 5 (3 or 4 moist), and chroma of 2 or 3. It is silty clay or clay. Reaction ranges from slightly acid to moderately alkaline. The B3 horizon has hue of 10YR to 5YR, value of 4 to 6 (3 to 5 moist), and chroma of 3 or 4. It is silty clay or silty clay loam. Reaction ranges from neutral to moderately alkaline. The lower part of the B2t horizon and the B3 horizon is 15 to 25 percent exchangeable sodium.

Elmont series

The Elmont series consists of deep, well drained, moderately slowly permeable soils on uplands. These soils formed in material weathered from shale. Slopes range from 1 to 7 percent.

Elmont soils are similar to Martin soils and are commonly adjacent to Bates and Eram soils. The moderately well drained Martin soils have a silty clay B2t horizon. They occur on similar landscapes. The moderately deep Bates and Eram soils occur on side slopes above Elmont soils.

Typical pedon in an area of Elmont silt loam, 4 to 7 percent slopes, 2,100 feet east and 300 feet north of southwest corner sec. 2, T. 21 S., R. 11 E.

A1—0 to 12 inches; dark grayish brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; moderate medium and fine granular structure; slightly hard, friable; slightly acid; gradual smooth boundary.

B21t—12 to 20 inches; brown (10YR 4/3) silty clay loam, dark brown (10YR 3/3) moist; moderate fine and medium subangular blocky structure; hard, friable; discontinuous clay films; slightly acid; gradual smooth boundary.

B22t—20 to 32 inches; brown (10YR 5/3) silty clay loam, brown (10YR 4/3) moist; common fine distinct yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; very hard, firm; thin dis-

continuous clay films; few fine black concretions; slightly acid; gradual smooth boundary.

B3—32 to 48 inches; yellowish brown (10YR 5/4) silty clay loam, dark yellowish brown (10YR 4/4) moist; common fine distinct strong brown (7.5YR 5/6) mottles; weak medium blocky structure; very hard, very firm; few patchy clay films; common black concretions; slightly acid; gradual smooth boundary.

Cr—48 to 60 inches; very pale brown (10YR 7/4) shale of silty clay loam texture, yellowish brown (10YR 5/4) moist; massive with horizontal lamination.

Thickness of the solum ranges from 24 to 50 inches. The depth to weathered shale is typically 45 to 60 inches but ranges from 40 to 80 inches. The mollic epipedon ranges from 10 to 24 inches in thickness. Reaction in the solum ranges from medium acid to neutral. Reaction in the C horizon is slightly acid to neutral.

The A horizon has hue of 10YR or 7.5YR, value of 3 or 5 (2 or 3 moist), and chroma of 1 to 3. It is typically silt loam or silty clay loam.

The B21t horizon has hue of 10YR or 7.5YR, value of 4 or 5 (2 to 4 moist), and chroma of 2 to 4. The B22t and B3 horizons have hue of 10YR or 7.5YR, value of 4 to 6 (4 or 5 moist), and chroma of 2 to 4. Depth to mottling is more than 16 inches. In many pedons the B3 horizon contains black concretions.

Eram series

The Eram series consists of moderately deep, moderately well drained, slowly permeable soils on uplands. These soils formed in material weathered from shale. Slopes range from 3 to 12 percent.

Eram soils are similar to Kenoma soils and are commonly adjacent to Bates and Elmont soils. The deep Kenoma soils are on ridgetops. Bates soils have a clay loam B2t horizon. They are on lower side slopes. The deep Elmont soils are on foot slopes below Eram soils.

Typical pedon in an area of Eram silt loam, 3 to 6 percent slopes, 600 feet east of the northwest corner sec. 19, T. 21 S., R. 11 E.

A1—0 to 9 inches; dark grayish brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; moderate medium and fine granular structure; slightly hard, friable; many fine and medium roots; slightly acid; gradual smooth boundary.

B2t—9 to 19 inches; brown (10YR 4/3) silty clay, dark brown (10YR 3/3) moist; common fine and medium distinct strong brown (7.5YR 5/6) and light brownish gray (10YR 6/2) mottles; moderate medium and fine blocky structure; extremely hard, extremely firm; nearly continuous clay films on most ped faces; few fine roots; slightly acid; gradual smooth boundary.

B3—19 to 34 inches; brown (10YR 5/3) silty clay, dark brown (10YR 3/3) moist; many fine and medium distinct pale brown (10YR 6/3) and strong brown (7.5YR 5/6) mottles; weak medium and coarse blocky structure; very hard, very firm; few shale lenses and hard sandstone pebbles; slightly acid; gradual smooth boundary.

Cr—34 inches; very pale brown (10YR 7/3), yellowish brown (10YR 5/6), and light gray (10YR 7/2) clayey shale; weak thin platy structure; extremely hard, very firm; mildly alkaline.

Thickness of the solum and depth to shale range from 20 to 40 inches.

The A horizon has hue of 10YR, value of 4 or 5 (2 or 3 moist), and chroma of 2 or 3. It is silt loam or silty clay loam. Reaction is medium acid to slightly acid unless the soil is limed.

The B2t and B3 horizons have hue of 10YR, value of 4 to 6 (3 to 5 moist), and chroma of 2 to 4. They have gray and brown mottles. They are strongly acid to neutral in reaction. The B horizon is silty clay or silty clay loam.

Florence series

The Florence series consists of deep, well drained, moderately slowly permeable soils on uplands. These soils formed in material weathered from cherty limestone. Slopes range from 6 to 12 percent.

Florence soils are similar to Olpe soils and are commonly adjacent to Kenoma and Tully soils. Olpe soils are deeper than Florence soils. They formed in material weathered from gravelly old alluvial sediments. Kenoma and Tully soils do not have significant amounts of chert fragments in the solum. Kenoma soils are on ridgetops. Tully soils are on foot slopes below Florence soils.

The Florence soils in this county are mapped only with Labette soils.

Typical pedon in an area of Florence cherty silt loam (fig. 6) in an area of Florence-Labette complex, 2 to 12 percent slopes, near center of sec. 13, T. 16 S., R. 10 E.

A1—0 to 13 inches; dark grayish brown (10YR 4/2) cherty silt loam, very dark brown (10YR 2/2) moist; moderate medium granular structure; slightly hard, friable; abundant roots; 40 percent by volume angular chert one-half inch to 3 inches across; slightly acid; clear irregular boundary.

B1—13 to 18 inches; dark brown (7.5YR 4/2) cherty silty clay loam, dark brown (7.5YR 3/2) moist; strong fine subangular blocky structure; very hard, very firm; 60 percent by volume chert fragments one-half inch to 3 inches across; slightly acid; clear irregular boundary.

B21t—18 to 36 inches; reddish brown (2.5YR 4/4) cherty clay, dark reddish brown (2.5YR 3/4) moist; moderate medium and fine blocky structure; extremely hard, extremely firm; black coatings on surfaces of

peds; few roots; 75 percent by volume angular chert fragments; slightly acid; gradual irregular boundary.

B22t—36 to 46 inches; reddish brown (2.5YR 4/4) cherty clay, dark reddish brown (2.5YR 3/4) moist; moderate fine and medium blocky structure; extremely hard, extremely firm; 80 percent by volume coarse chert fragments; mildly alkaline; clear irregular boundary.

R—46 inches; massive cherty limestone with a few crevices filled with red clay.

Thickness of the solum and depth to bedrock range from 40 to 60 inches. The mollic epipedon is 10 to 20 inches thick.

The A horizon has hue of 7.5YR or 10YR, value of 3 or 4 (2 or 3 moist), and chroma of 1 or 2. It is dominantly cherty silt loam, but the range includes cherty silty clay loam. It is as much as 50 percent chert fragments. Reaction ranges from medium acid to neutral.

The B1 horizon has hue of 10YR, 7.5YR or 5YR, value of 3 or 4 (2 or 3 moist), and chroma of 1 or 2. Reaction is medium acid to neutral. The B2t horizon has hue of 7.5YR, 5YR, or 2.5YR, value of 3 to 5 (3 to 5 moist), and chroma of 3 to 6. It is cherty clay or cherty silty clay. Reaction is medium acid to neutral. In some pedons the cherty limestone has weathered away, and the soil is underlain with shale.

Ivan series

The Ivan series consists of deep, moderately well drained, moderately permeable soils on flood plains. These soils formed in silty and loamy alluvial sediments. The slope is 0 to 2 percent.

Ivan soils are adjacent to Reading and Chase soils. Chase and Reading soils occupy stream terraces. They have a B2t horizon.

Typical pedon in an area of Ivan silt loam, 50 feet north and 2,100 feet east of the southwest corner sec. 36, T. 21 S., R. 10 E.

A1—0 to 20 inches; dark grayish brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; moderate medium granular structure; slightly hard, friable; many worm casts; few small limestone chips; strong effervescence; moderately alkaline; gradual smooth boundary.

AC—20 to 35 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; slightly hard, friable; few small limestone chips; strong effervescence; moderately alkaline; gradual smooth boundary.

C—35 to 60 inches; grayish brown (10YR 5/2) loam, dark grayish brown (10YR 4/2) moist; massive; slightly hard, friable; many small limestone fragments; strong effervescence; moderately alkaline.

The depth to lime is less than 10 inches. The soil contains lime throughout all horizons between depths of 10 and 40 inches. The upper 10 inches is mildly alkaline or moderately alkaline. Below 10 inches the soil is moderately alkaline in all horizons.

The A and AC horizons have hue of 10YR, value of 4 or 5 (2 to 3 moist), and chroma of 1 or 2. They are dominantly silt loam, but the range includes silty clay loam.

The C horizon has hue of 10YR, value 5 or 6 (3 to 5 moist), and chroma of 2 or 3. It is loam or silt loam.

Kenoma series

The Kenoma series consists of deep, moderately well drained, very slowly permeable soils in uplands. These soils formed in old clayey alluvium. Slopes range from 1 to 7 percent.

Kenoma soils are similar to Eram soils and are commonly adjacent to Elmont and Ladysmith soils. Eram soils are moderately deep. Elmont soils have a silty clay loam B2t horizon. They are on foot slopes below Kenoma soils. Ladysmith soils have a darker colored B2t horizon than Kenoma soils. They are on ridgetops.

Typical pedon in an area of Kenoma silt loam, 1 to 3 percent slopes, 2,540 feet north and 50 feet west of southeast corner sec. 27, T. 19 S., R. 13 E.

A1—0 to 10 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak to moderate fine granular structure; slightly hard, friable; many roots; medium acid; abrupt wavy boundary.

B21t—10 to 20 inches; grayish brown (10YR 5/2) silty clay, very dark grayish brown (10YR 3/2) moist; common fine faint brown (10YR 4/3) and yellowish brown (10YR 4/4) mottles; weak coarse prismatic structure parting to weak fine blocky; very hard, very firm; common fine roots; few fine pores; few worm casts; medium acid; clear irregular boundary.

B22t—20 to 26 inches; brown (10YR 4/3) silty clay, dark brown (10YR 3/3) moist; few fine vertical streaks of very dark brown (10YR 2/2) moist; common fine and medium faint dark yellowish brown (10YR 4/4) and reddish brown (5YR 4/4) mottles; weak coarse blocky structure; very hard, very firm; few fine rounded chert fragments; slightly acid; clear wavy boundary.

B23t—26 to 40 inches; dark grayish brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) moist; common fine faint yellowish brown (10YR 5/6) and reddish brown (5YR 4/4) mottles; weak coarse and medium blocky structure; very hard, very firm; few fine rounded chert fragments; neutral; gradual irregular boundary.

B3—40 to 60 inches; yellowish brown (10YR 5/4) silty clay, dark yellowish brown (10YR 4/4) moist;

common fine faint dark grayish brown (10YR 4/2) and brown (7.5YR. 4/3) mottles; weak medium blocky structure; very hard, very firm; 5 percent rounded chert fragments; moderately alkaline.

The thickness of the solum ranges from 36 to 60 inches. The depth to limestone or shale is more than 40 inches.

The A horizon has hue of 10YR, value of 4 or 5 (2 or 3 moist), and chroma of 1 or 2. It is silt loam or silty clay loam. It ranges from strongly acid to slightly acid.

The B21t horizon has hue of 10YR or 7.5YR, value of 4 or 5 (2 or 3 moist), and chroma of 2 or 3. The B22t and B23t horizons have hue of 10YR or 7.5YR, value of 4 to 7 (3 to 6 moist), and chroma of 2 to 5. They are silty clay or clay. Reaction ranges from medium acid to mildly alkaline. The B2t horizon has common to many brown, yellowish brown, or reddish brown mottles.

The B3 horizon has hue of 5YR to 2.5Y, value of 4 to 6 (4 or 5 moist), and chroma of 2 to 6. It has brown or red mottles. It is silty clay or silty clay loam. Reaction ranges from slightly acid to moderately alkaline.

Labette series

The Labette series consists of moderately deep, well drained, slowly permeable soils on uplands. These soils formed in material weathered from limestone and interbedded shale. Slopes range from 1 to 6 percent.

Labette soils are similar to Tully soils and are commonly adjacent to Kenoma and Sogn soils. The deep Tully soils are on foot slopes. Kenoma soils are deep. They do not have a B1 horizon. They occur on ridgetops above Labette soils. Sogn soils are shallow. They are below Labette soils.

Typical pedon in an area of Labette silty clay loam, 1 to 3 percent slopes, 2,720 feet east and 50 feet north of southwest corner sec. 34, T. 19 S., R. 11 E.

A1—0 to 8 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark brown (10YR 2/2) moist; strong fine and medium granular structure; slightly hard, friable; few pores; many fine roots; slightly acid; gradual smooth boundary.

B1—8 to 13 inches; dark brown (7.5YR 4/2) silty clay loam, dark brown (7.5YR 3/2) moist; strong fine and very fine subangular blocky structure; hard, firm; few thin patchy clay films, many pores; many fine roots; slightly acid; gradual smooth boundary.

B21t—13 to 23 inches; brown (7.5YR 5/4) silty clay, brown (7.5YR 4/4) moist; moderate fine blocky structure; very hard, firm; common fine roots; distinct clay films cover most ped faces; slightly acid; gradual wavy boundary.

B22t—23 to 33 inches; reddish brown (5YR 5/3) silty clay, reddish brown (5YR 4/3) moist; moderate fine and medium blocky structure; very hard, very firm; distinct clay films cover most ped faces; few fine black concretions; neutral; gradual wavy boundary.

C—33 to 38 inches; reddish brown (5YR 5/4) silty clay, reddish brown (5YR 4/4) moist; massive; very hard, firm; 15 percent soft shale and limestone fragments; many small hard black concretions; moderately alkaline; clear wavy boundary.

R—38 inches; hard jointed limestone that has little displacement of large fragments.

The thickness of the solum and the depth to bedrock range from 20 to 40 inches. The solum is medium acid or slightly acid in the upper part and medium acid, neutral, or mildly alkaline in the lower part.

The A horizon has hue of 10YR or 7.5YR, value of 3 to 5 (2 to 3 moist), and chroma of 1 or 2. It is dominantly silty clay loam, but the range includes silt loam. Some pedons have a cherty texture.

The B1 horizon has hue of 10YR to 5YR, value of 3 to 5 (2 or 3 moist), and chroma of 2 or 3. The B2t horizon has hue of 7.5YR to 2.5YR, value of 4 to 6 (3 to 5 moist), and chroma of 2 to 6. It is silty clay or silty clay loam.

The C horizon has hue of 10YR or 2.5YR, value of 4 to 6 (4 to 6 moist), and chroma of 4 to 6. It is silty clay or silty clay loam. Reaction ranges from neutral to moderately alkaline.

Ladysmith series

The Ladysmith series consists of deep, moderately well drained, very slowly permeable soils on uplands. These soils formed in material weathered from old alluvium or eolian sediments. Slopes are 0 to 2 percent.

Ladysmith soils are similar to Dwight soils and are commonly adjacent to Kenoma soils. Dwight soils have a thin A horizon and a natric horizon. Kenoma soils occur below Ladysmith soils and have higher chroma in the B2t horizon.

Typical pedon in an area of Ladysmith silty clay loam (fig. 7), 0 to 2 percent slopes, 1,960 feet south and 1,320 feet west of northeast corner sec. 12., T. 19 S., R. 10 E.

A1—0 to 8 inches; dark gray (10YR 4/1) silty clay loam, black (10YR 2/1) moist; moderate fine and medium granular structure; slightly hard, friable; many roots; medium acid; clear smooth boundary.

B21t—8 to 29 inches; dark gray (10YR 4/1) silty clay, black (10YR 2/1) moist; moderate coarse blocky structure parting to weak fine blocky; very hard, very firm; few fine roots; few shiny surfaces on ped faces; slightly acid; gradual smooth boundary.

B22t—29 to 37 inches; dark grayish brown (10YR 4/2) silty clay, very dark grayish brown (2.5Y 3/2) moist; moderate medium subangular blocky structure; common fine faint yellowish brown (10YR 5/6) mot-

tles; very hard, very firm; few small hard carbonate concretions; few fine roots; mildly alkaline; gradual boundary.

C1—37 to 46 inches; light brownish gray (10YR 6/2) silty clay loam, dark grayish brown (10YR 4/2) moist; common faint yellowish brown (10YR 5/6) mottles; massive; hard, firm; few black hard concretions; moderately alkaline; gradual smooth boundary.

C2—46 to 60 inches; light gray (10YR 7/2) silty clay loam, grayish brown (10YR 5/2) moist; many medium prominent yellowish brown (10YR 5/6) and dark yellowish brown (10YR 4/4) mottles; massive; hard, firm; moderately alkaline.

Thickness of the solum ranges from 36 to 60 inches. Thickness of the mollic epipedon ranges from 20 to 40 inches.

The A horizon has hue of 10YR, value of 3 to 5 (2 or 3 moist), and chroma of 2 or less. It is dominantly silty clay loam, but the range includes silt loam. Reaction ranges from medium acid to neutral.

The B2t horizon has hue of 10YR, value of 3 to 5 (2 or 3 moist), and chroma of 2 or less. It is silty clay or clay. Reaction ranges from slightly acid to mildly alkaline. Some pedons have a B3 horizon. The B3 and C horizons have hue of 10YR or 2.5Y, values of 5 to 7 (4 to 6 moist), and chroma of 1 to 3. Reaction ranges from neutral to moderately alkaline. The texture is silty clay loam or silty clay. In some pedons soft clayey shale is below 40 inches.

Martin series

The Martin series consists of deep, moderately well drained, slowly permeable soils on uplands. These soils formed in clayey material weathered from shale. The slope ranges from 1 to 7 percent.

Martin soils are similar to Ladysmith soils and are commonly adjacent to Clime and Labette soils. Ladysmith soils have an abrupt boundary between the A and B2t horizons. They are on ridgetops. Clime soils are moderately deep and calcareous. Labette soils are moderately deep over limestone. Clime and Labette soils are above Martin soils.

Typical pedon in an area of Martin silty clay loam, 4 to 7 percent slopes, 1,000 feet east and 660 feet south of the northwest corner sec. 35, T. 21 S., R. 12 E.

A1—0 to 12 inches; dark gray (10YR 4/1) silty clay loam, black (10YR 2/1) moist; strong medium granular structure; hard, friable; slightly acid; many fine roots; clear smooth boundary.

B1—12 to 18 inches; dark gray (10YR 4/1) silty clay, very dark gray (10YR 3/1) moist; strong fine and medium subangular blocky structure; very hard, firm; many fine roots; most peds have shiny surfaces; slightly acid; gradual smooth boundary.

B21t—18 to 34 inches; very dark grayish brown (10YR 3/2) silty clay, very dark brown (10YR 2/2) moist; moderate medium and coarse blocky structure; very hard, very firm; distinct continuous clay films; few fine roots; medium acid; diffuse smooth boundary.

B22t—34 to 48 inches; grayish brown (2.5Y 5/2) silty clay, dark grayish brown (2.5Y 4/2) moist; few fine distinct yellowish brown (10YR 5/6) mottles; moderate medium and coarse blocky structure; very hard, very firm; distinct and continuous clay films; few small black concretions; neutral; gradual wavy boundary.

B3—48 to 60 inches; light olive brown (2.5Y 5/3) silty clay, olive brown (2.5Y 4/3) moist; common fine distinct yellowish brown (10YR 5/6) mottles and common streaks of very dark gray (10YR 3/1) between peds; weak coarse blocky structure; extremely hard, extremely firm; few fine black concretions; neutral.

Thickness of the solum ranges from 40 to 60 inches. Thickness of the mollic epipedon ranges from 24 to 36 inches.

The A horizon has hue of 10YR, value of 3 to 4 (2 or 3 moist), and chroma of 1 or 2. It is silty clay loam or silty clay. Reaction is medium acid or slightly acid.

The B horizon has hue of 10YR or 2.5Y, value of 3 to 5 (2 to 4 moist), and chroma of 1 or 2 in the upper part and 1 to 4 in the lower part. It is silty clay or clay. Reaction ranges from medium acid to neutral. Mottles are commonly few and faint in the upper part of the B horizon but become common and distinct in the lower part. Some pedons have lime concretions in the lower part of the B horizon.

Olpe series

The Olpe series consists of deep, well drained, slowly permeable soils on uplands. These soils formed in old gravelly alluvial sediments. Slopes range from 3 to 15 percent.

Olpe soils are similar to Florence soils and are commonly adjacent to Kenoma and Martin soils. Florence soils have angular chert fragments in the solum. They formed in material weathered from cherty limestone. Kenoma soils have few or no chert fragments, and Martin soils have no chert fragments. Kenoma soils are on lower side slopes in the Olpe-Kenoma complex and also on broad ridgetops above the complex. Martin soils are on foot slopes below Olpe soils.

Olpe soils in this county are mapped only with Kenoma soils.

Typical pedon of Olpe gravelly silt loam in an area of Olpe-Kenoma complex, 3 to 15 percent slopes, 2,000 feet west and 100 feet south of northeast corner sec. 5, T. 19 S., R. 12 E.

A11—0 to 10 inches; dark grayish brown (10YR 4/2) gravelly silt loam, very dark brown (10YR 2/2) moist; moderate fine granular structure; slightly hard, friable; many fine roots; 15 percent small rounded chert gravel; medium acid; gradual wavy boundary.

A12—10 to 15 inches; brown (7.5YR 5/2) gravelly silt loam, dark brown (7.5YR 3/2) moist; moderate medium granular structure; slightly hard, friable; many fine roots; 30 percent rounded chert gravel; medium acid; gradual wavy boundary.

B1—15 to 25 inches; reddish brown (5YR 5/3) gravelly silty clay loam, reddish brown (5YR 4/3) moist; moderate medium and fine subangular blocky structure; hard, firm; common fine roots; 60 percent rounded chert gravel; medium acid; gradual wavy boundary.

B2t—25 to 43 inches; reddish brown (5YR 5/4) gravelly silty clay, reddish brown (5YR 4/4) moist; moderate fine and medium blocky structure; very hard, extremely firm; few roots; continuous thick clay films; 85 percent rounded chert gravel; slightly acid; diffuse wavy boundary.

B3—43 to 60 inches; reddish brown (5YR 5/4) gravelly silty clay, reddish brown (5YR 4/4) moist; few fine prominent reddish brown (2.5YR 4/4) and dark yellowish brown (10YR 4/6) mottles; moderate fine and medium blocky structure; extremely hard, extremely firm; 80 percent rounded chert gravel; slightly acid.

Thinkness of the solum is more than 60 inches. Thickness of the mollic epipedon ranges from 10 to 20 inches.

The A horizon has hue of 10YR or 7.5YR, value of 3 to 5 (2 or 3 moist), and chroma of 1 to 3. It is dominantly gravelly silt loam, but the range includes silt loam, silty clay loam, and gravelly silty clay loam. Reaction is strongly acid to slightly acid.

The B1 horizon has hue of 2.5YR to 7.5YR, value of 4 or 5 (3 or 4 moist), and chroma of 2 to 4. It is strongly acid to slightly acid. The B2t horizon has hue of 2.5YR to 7.5YR, value of 4 or 5 (3 or 4 moist), and chroma of 4 to 6. It is medium acid to neutral. Red or gray mottles are common in the B2t horizon. Mottles with chroma of 2 or less are lacking in the upper 20 inches of the argillic horizon.

Osage series

The Osage series consists of deep, poorly drained, very slowly permeable soils on flood plains. They formed in clayey alluvial sediments. Slopes are 0 to 2 percent.

Osage soils are similar to Zaar soils and are commonly adjacent to Chase and Reading soils. Zaar soils formed in material weathered from shale. They are on uplands. Chase and Reading soils have an argillic horizon. They are on stream terraces.

Typical pedon in an area of Osage silty clay, 2,640 feet west of northeast corner sec. 27, T. 19 S., R. 11 E.

A1—0 to 13 inches; dark gray (10YR 4/1) silty clay, black (10YR 2/1) moist; weak fine granular structure; very hard, very firm; many fine roots; slightly acid; gradual smooth boundary.

B21g—13 to 28 inches; dark gray (10YR 4/1) silty clay, black (10YR 2/1) moist; few fine faint yellowish brown (10YR 5/4) mottles; weak fine blocky structure; extremely hard, extremely firm; few fine roots; neutral; diffuse smooth boundary.

B22g—28 to 41 inches; dark gray (10YR 4/1) silty clay, very dark brown (10YR 2/2) moist; few fine faint dark yellowish brown (10YR 4/4) mottles; weak coarse blocky structure; extremely hard, extremely firm; few slickensides about 8 inches across; few fine roots; few small carbonate concretions; mildly alkaline; diffuse wavy boundary.

B3g—41 to 60 inches; gray (10YR 5/1) silty clay, dark gray (10YR 4/1) moist; common fine faint yellowish brown (10YR 5/4) and olive gray (5Y 4/2) mottles; weak coarse blocky structure; extremely hard, extremely firm; few small carbonate concretions; common slickensides about 8 inches across; mildly alkaline.

Solum thickness is 40 to 60 inches or more.

The A horizon has hue of 10YR or 2.5Y, value of 3 or 4 (2 or 3 moist), and chroma of 1 or 2. It is dominantly silty clay, but the range includes silty clay loam. Reaction is strongly acid to neutral.

The B horizon has hue of 10YR to 5Y, value of 3 to 5 (2 to 4 moist), and chroma of 1 or 2. It ranges from medium acid to neutral in the upper part and from slightly acid to mildly alkaline in the lower part. It has mottles with chroma of 3 or more.

Reading series

The Reading series consists of deep, well drained, moderately slowly permeable soils on stream terraces. These soils formed in silty alluvial sediments. Slopes range from 0 to 2 percent.

Reading soils are similar to Tully soils and are commonly adjacent to Chase and Ivan soils. Tully soils have a silty clay B2t horizon. They are on foot slopes. Chase soils have a silty clay B2t horizon. They are in low areas adjacent to uplands. Ivan soils do not have a Bt horizon. They are on flood plains.

Typical pedon in an area of Reading silt loam (fig. 8), 2,640 feet west of southeast corner sec. 36, T. 21 S., R. 10 E.

Ap—0 to 9 inches; dark grayish brown (10YR 4/2) silt loam, very drak grayish brown (10YR 3/2) moist; weak fine and medium granular structure; slightly hard, friable; medium acid; abrupt smooth boundary.

A12—9 to 17 inches; dark grayish brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist;

moderate fine and medium granular structure; slightly hard, friable; slightly acid; gradual smooth boundary.

B1—17 to 24 inches; dark brown (10YR 4/3) silty clay loam, dark brown (10YR 3/3) moist; moderate fine subangular blocky structure; hard, firm; dark coatings on ped faces are thin and patchy; slightly acid; gradual smooth boundary.

B2t—24 to 45 inches; dark yellowish brown (10YR 4/4) silty clay loam, dark brown (10YR 3/3) moist; moderate medium subangular blocky and blocky structure; hard, firm; dark coatings on ped faces are distinct and continuous; neutral; gradual smooth boundary.

B3—45 to 60 inches; yellowish brown (10YR 5/4) silty clay loam, dark yellowish brown (10YR 3/4) moist; weak fine subangular blocky structure; hard, firm; neutral.

The thickness of the solum ranges from about 45 to 60 inches or more. The mollic epipedon is more than 24 inches thick. The A and B horizons are medium acid to neutral.

The A horizon has hue of 10YR, value of 3 to 5 (2 or 3 moist), and chroma of 1 to 3. It is dominantly silt loam, but the range includes silty clay loam.

The B horizon has hue of 7.5YR or 10YR, value of 3 to 5 (2 to 4 moist), and chroma of 2 to 4. The B2t horizon is 27 to 35 percent clay.

The C horizon has hue of 10YR or 7.5YR, value of 5 or 6 (4 or 5 moist), and chroma of 2 to 4. It is silty clay loam or silty clay. Reaction is slightly acid to moderately alkaline.

Sogn series

The Sogn series consists of shallow, somewhat excessively drained, moderately permeable soils on uplands. These soils formed in material weathered from limestone. Slopes range from 0 to 9 percent.

Sogn soils are similar to Vinland soils and are commonly adjacent to Clime and Labette soils. Vinland soils are shallow over shale. The calcareous Clime soils are moderately deep. They occur below Sogn soils. Labette soils are moderately deep. They are on ridgetops.

The Sogn soils in this county are mapped only with Clime soils.

Typical pedon of Sogn silty clay loam in an area of Clime-Sogn complex, 5 to 20 percent slopes, near shelter house south side of dam on Reading Lake in sec. 26, T. 17 S., R. 12 E.

A1—0 to 9 inches; dark gray (10YR 4/1) silty clay loam, very dark brown (10YR 2/2) moist; moderate fine and medium granular structure; slightly hard, friable; many fine roots; neutral; abrupt smooth boundary.

R—9 inches; platy indurated limestone; few crevices filled with dark gray silty clay loam soil material.

Thickness of the solum ranges from 4 to 20 inches. The A horizon has hue of 10YR, value of 3 to 5 (2 to 3 moist), and chroma of 1 to 3. Reaction ranges from slightly acid to moderately alkaline. Less than 35 percent of the soil mass is fragments of limestone.

Tully series

The Tully series consists of deep, well drained, slowly permeable soils on foot slopes. These soils formed in material weathered from limestone and interbedded shale. Slopes range from 2 to 15 percent.

Tully soils are similar to Labette soils and are commonly adjacent to Clime and Florence soils. Labette soils are moderately deep over limestone. Clime soils are calcareous and moderately deep over shale. Florence soils have chert fragments in the solum. Clime and Florence soils are on side slopes above areas of Tully soils.

Typical pedon in an area of Tully silty clay loam, 2 to 7 percent slopes, 50 feet north and 750 feet west of southeast corner sec. 6, T. 16 S., R. 11 E.

A1—0 to 10 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark brown (10YR 2/2) moist; moderate fine and medium granular structure; hard, friable; many fine roots; slightly acid; clear smooth boundary.

B1—10 to 17 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark brown (10YR 2/2) moist; moderate fine subangular blocky structure; very hard, firm; many fine roots; slightly acid; clear smooth boundary.

B21t—17 to 30 inches; dark grayish brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) moist; moderate fine and medium blocky structure; very hard, firm; common fine roots; 5 percent fine chert fragments; slightly acid; gradual smooth boundary.

B22t—30 to 48 inches; grayish brown (10YR 5/2) silty clay, dark grayish brown (10YR 4/2) moist; few fine faint yellowish brown (10YR 5/4) mottles; moderate medium blocky structure parting to weak fine blocky; very hard, very firm; few fine roots; 5 percent chert fragments less than one-half inch in diameter; mildly alkaline; gradual smooth boundary.

B3—48 to 60 inches; brown (7.5YR 5/4) silty clay, dark brown (7.5YR 3/3) moist; few fine faint yellowish brown (10YR 5/4) mottles; weak fine and medium blocky structure; very hard, firm; 5 percent fine chert fragments; few carbonate concretions; few small black concretions; mildly alkaline.

Thickness of the solum ranges from 36 to 60 inches. The depth to lime ranges from 30 to 70 inches or more.

The A1 and B1 horizons have hue of 10YR or 7.5YR, value of 3 to 5 (2 or 3 moist), and chroma of 1 to 3. The A horizon is dominantly silty clay loam, but the range includes silt loam and cherty silty clay loam. The B1 horizon is silty clay loam or cherty silty clay loam.

The B21t horizon has hue of 10YR or 7.5YR, value of 4 or 5 (3 or 4 moist), and chroma of 2 or 3. The B22t horizon has hue of 7.5YR or 10YR, value of 4 to 6 (3 to 5 moist), and chroma of 2 to 4. The B2 horizon is silty clay or silty clay loam or the cherty analogs. Reaction in the B21t and B22t horizons ranges from slightly acid to moderately alkaline.

The B3 horizon has hue of 10YR or 7.5YR, value of 4 to 6 (3 to 5 moist), and chroma of 2 to 4. It is silty clay or silty clay loam or the cherty analogs. Reaction ranges from neutral to moderately alkaline.

Vinland series

The Vinland series consists of shallow, somewhat excessively drained, moderately permeable soils on uplands. These soils formed in material weathered from sandy or silty shale. Slopes range from 4 to 10 percent.

Vinland soils are similar to Sogn soils and are commonly adjacent to Bates, Elmont, and Eram soils. Sogn soils are shallow over limestone. The moderately deep Bates soils have a B2t horizon. They are on ridgetops above Vinland soils. Elmont soils are deep and Eram soils moderately deep over shale. Both occur below areas of Vinland soils.

Typical pedon in an area of Vinland loam, 4 to 10 percent slopes, 1,420 feet north and 100 feet east of southwest corner sec. 35, T. 21 S., R. 12 E.

A1—0 to 7 inches; dark grayish brown (10YR 4/2) loam, very dark brown (10YR 2/2) moist; moderate fine and medium granular structure; slightly hard, friable; many fine roots; medium acid; gradual smooth boundary.

B2—7 to 12 inches; dark grayish brown (10YR 4/2) loam; very dark grayish brown (10YR 3/2) moist; weak fine subangular blocky structure; slightly hard, friable; many fine roots; 10 percent small soft silty shale fragments; slightly acid; clear wavy boundary.

C1—12 to 19 inches; brown (10YR 5/3) loam; dark brown (10YR 4/3) moist; massive; hard, friable; about 15 percent soft silty shale fragments; slightly acid; clear wavy boundary.

Cr—19 inches; brown (10YR 5/3) weathered soft interbedded sandy and silty shale; neutral.

Solum thickness and depth to bedrock are 10 to 20 inches. The mollic epipedon is 8 to 12 inches thick. It is medium acid to neutral. It is less than 15 percent by volume rock fragments less than 2 inches in diameter.

The A horizon has hue of 10YR or 7.5YR, value of 3 to 5 (2 or 3 moist), and chroma of 1 or 2. It is dominantly loam, but the range includes fine sandy loam.

The B2 horizon has hue of 10YR or 7.5YR, value of 4 to 6 (3 to 5 moist), and chroma of 2 to 4. It is loam or fine sandy loam.

The C horizon has hue of 10YR, 7.5YR or 2.5Y, value of 5 to 8 (4 to 7 moist), and chroma of 2 to 4. It is loam or fine sandy loam.

Zaar series

The Zaar series consists of deep, somewhat poorly drained, very slowly permeable soils on uplands. These soils formed in material weathered from shale. Slopes range from 2 to 5 percent.

Zaar soils are similar to Osage soils and are commonly adjacent to Clime and Sogn soils. Osage soils are poorly drained and are frequently flooded. The calcareous Clime soils are moderately deep, have steeper slopes, and are above Zaar soils. Sogn soils are shallow over limestone. They are below Zaar soils.

Typical pedon in an area of Zaar silty clay, 2 to 5 percent slopes, 1,000 feet south and 50 feet west of northeast corner sec. 8, T. 20 S., R. 10 E.

A1—0 to 14 inches; dark gray (10YR 4/1) silty clay, black (10YR 2/1) moist; moderate fine and medium subangular blocky structure, parting to fine and medium granular; hard, firm; slightly acid; gradual wavy boundary.

B21—14 to 29 inches; very dark grayish brown (10YR 3/2) silty clay, very dark brown (10YR 2/2) moist; with many streaks of very dark gray (10YR 3/1), black (10YR 2/1) moist; few fine faint yellowish brown (10YR 5/6) mottles; weak medium and coarse blocky structure; extremely hard, extremely firm; few slickensides; few small hard black concretions; neutral; gradual wavy boundary.

B22—29 to 40 inches; dark grayish brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) moist; common fine faint olive brown (2.5Y 4/4) and yellowish brown (10YR 5/6) mottles; weak coarse blocky structure; extremely hard, extremely firm; few slickensides; few black concretions; neutral; diffuse wavy boundary.

B3—40 to 60 inches; grayish brown (2.5Y 5/3) silty clay, dark grayish brown (2.5Y 4/3) moist; common medium distinct yellowish brown (10YR 5/6) mottles; weak medium blocky structure; extremely hard, extremely firm; slickensides larger and more common than in B22; few carbonate concretions; mildly alkaline.

Thickness of the solum ranges from 40 to 70 inches. Depth to weathered shale is more than 45 inches. Thickness of the mollic epipedon ranges from 20 to 40 inches.

The A horizon has hue of 10YR or 2.5Y, value of 3 or 4 (2 or 3 moist), and chroma of 1 or 2. It is dominantly silty clay, but the range includes silty clay loam. Reaction is medium acid or slightly acid.

The B21 horizon has hue of 10YR or 5Y, value of 3 to 5 (2 to 4 moist), and chroma of 1 to 3. It is silty clay, clay, or silty clay loam. Reaction ranges from neutral to moderately alkaline. The B22 horizon has hue of 10YR or 5Y, value of 4 to 6 (3 to 5 moist), and chroma of 2 to 4. It is silty clay or clay. The soil ranges from neutral to moderately alkaline. It may have mottles with chroma of 3 or more. The B3 horizon has hue of 10YR or 5Y, value of 5 or 6 (4 or 5 moist), and chroma of 3 to 6. It is silty clay, clay, or silty clay loam. Slickensides are common.

Formation of the soils

This section describes the factors of soil formation and explains how these factors have affected the soils of Lyon County.

Soil forms through the physical and chemical weathering of parent material. The characteristics of the soil at any given point are determined by (1) the physical and mineral composition of the parent material, (2) the climate under which the soil material has accumulated and existed since accumulation, (3) the plant and animal life on the soil, (4) the relief, or lay of the land, and (5) the length of time the forces of soil formation have acted on the soil material.

Climate and plant and animal life, chiefly plants, are active factors of soil formation. They act on the parent material that has accumulated through the weathering of rocks and slowly change it to a natural body that has genetically related horizons. The effects of climate and plant and animal life are conditioned by relief. The parent material also affects the kind of soil profile that forms and in extreme cases determines it almost entirely. Finally, time is needed for changing the parent material into soil. Generally, a long time is required for the development of distinct horizons.

The factors of soil formation are so closely interrelated in their effects on the soil that few generalizations can be made regarding the effect of any one factor unless conditions are specified for the other four. Many of the processes of soil development are unknown.

Parent material.—Parent material is the unconsolidated mass from which soil forms. Parent material is formed by the weathering of rocks through freezing and thawing, abrasion, erosion, and chemical processes and by the deposition of material by wind and water.

Bates, Clime, Florence, Labette, Martin, and Sogn soils formed in material weathered from bedrock. Florence soils formed in material weathered from cherty limestone. Sogn and Labette soils formed in material weathered from limestone. Bates soils formed in material weathered from sandstone. Clime and Martin soils formed in material weathered from shale.

Most of the broader upland divides east of the Flint Hills are covered with old alluvial deposits of gravel, sand, silt, and clay. These deposits are a few inches to about 15 feet thick. Kenoma and Dwight soils formed in these silty and clayey deposits. Olpe soils formed in gravelly deposits.

Recent alluvium consists of the sand, silt, and clay deposited on flood plains and low stream terraces by present streams. Chase, Ivan, Osage, and Reading soils occur in these deposits in the larger valleys throughout the county. The properties of alluvium are influenced by the nature of the geological materials within the drainage area. Ivan soils, which are on the flood plain of streams that drain limestone-shale areas, contain free lime and are moderately alkaline.

Deposits of eolian silt and clay occur on most of the nearly level ridgetops of broad upland divides. The depth of these deposits is usually less than 5 feet. Ladysmith soils formed in eolian material or old alluvium.

Climate.—Climate influences both the chemical and physical weathering and the biological processes at work in the parent material. Soil-forming processes are most active when the soil is warm and moist. Water is of major importance in the weathering of soils. Alternate wetting and drying, along with freezing and thawing, contribute to the physical weathering of soils and parent material. For detailed information on the climate of Lyon County, see "Climate."

Plants and animals.—Plants and animals furnish organic matter to the soil and bring plant nutrients from lower layers to the surface. Stems, leaves, and roots are the principal sources of organic matter. The organic matter modifies the color, structure, and other physical and chemical properties of the soil. Burrowing animals mix the soil horizons. Earthworms feed on organic matter and channel through the soil horizons.

The upland soils in Lyon County formed under tall grass prairie, which supplies a large quantity of organic matter that makes the surface layer dark. Martin, Tully, and Zaar soils are examples of dark colored prairie soils.

Relief.—Relief influences soil formation because it determines the amount of infiltration and runoff. Runoff is slow in level areas where most of the rainfall enters the soil. Generally, less water enters steep soils, and more soil material is lost through erosion. Relief, or slope exposure, also influences soil temperature and the natural plant community.

The effects of relief are expressed in the depth of Eram and Vinland soils in Lyon County. Both soils formed in material weathered from shale. The moderately deep Eram soils are on moderately sloping side slopes. The shallow Vinland soils are on strongly sloping hillsides.

Time.—Time influences the morphological effects of the active soil-forming factors. Ivan and Clime soils, for

example, are young soils in terms of morphological change. Their surface layer is not leached of soluble carbonates, and their lower horizons have no illuviated clay. Ladysmith and Martin soils, in contrast, are older and more advanced in morphological change.

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Glossary

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	More than 9

Base saturation. The degree to which material having base exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the exchange capacity.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bottom land. The normal flood plain of a stream, subject to frequent flooding.

Calcareous soil. A soil containing enough calcium carbonate (commonly with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid. A soil having measurable amounts of calcium carbonate or magnesium carbonate.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Claypan. A slowly permeable soil horizon that contains much more clay than the horizons above it. A claypan is commonly hard when dry and plastic or stiff when wet.

Climax vegetation. The stabilized plant community on a particular site. The plant cover reproduces itself and does not change so long as the environment remains the same.

Coarse fragments. Mineral or rock particles up to 3 inches (2 millimeters to 7.5 centimeters) in diameter.

Coarse textured (light textured) soil. Sand or loamy sand.

Complex, soil. A mapping unit of two or more kinds of soil occurring in such an intricate pattern that they cannot be shown separately on a soil map at the selected scale of mapping and publication.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Decreasers. The most heavily grazed climax range plants. Because they are the most palatable, they are the first to be destroyed by overgrazing.

Depth to rock. Bedrock at a depth that adversely affects the specified use.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drain-

age or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Five classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically for long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Drainage, surface. Runoff, or surface flow of water, from an area.

Eluviation. The movement of material in true solution or colloidal suspension from one place to another within the soil. Soil horizons that have lost material through eluviation are eluvial; those that have received material are illuvial.

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes a bare surface.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

First bottom. The normal flood plain of a stream, subject to frequent or occasional flooding.

Flooding. The temporary covering of soil with water from overflowing streams, runoff from adjacent slopes, and tides. Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *occasional* that it occurs on an average of once or less in 2 years; and *frequent* that it occurs on an average of more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; *November-May*, for example, means that flooding can occur during the period November through May. Water standing for short periods after rainfall or commonly covering swamps and marshes is not considered flooding.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Forb. Any herbaceous plant not a grass or a sedge.

Frost action. Freezing and thawing of soil moisture. Frost action can damage structures and plant roots.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.5 centimeters) in diameter. An individual piece is a pebble.

Habitat. The natural abode of a plant or animal; refers to the kind of environment in which a plant or animal normally lives, as opposed to the range or geographical distribution.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. The major horizons of mineral soil are as follows:

A horizon.—The mineral horizon, formed or forming at or near the surface, in which an accumulation of humified organic matter is mixed with the mineral

material. Also, a plowed surface horizon most of which was originally part of a B horizon.

A2 horizon.—A mineral horizon, mainly a residual concentration of sand and silt high in content of resistant minerals as a result of the loss of silicate clay, iron, aluminum, or a combination of these.

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or a combination of these; (2) by prismatic or blocky structure; (3) by redder or browner colors than those in the A horizon; or (4) by a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the A or B horizon. The material of a C horizon may be either like or unlike that from which the solum is presumed to have formed. If the material is known to differ from that in the solum the Roman numeral II precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock commonly underlies a C horizon, but can be directly below an A or a B horizon.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered, but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Increasers. Species in the climax vegetation that increase in amount as the more desirable plants are reduced by close grazing. Increasers commonly are the shorter plants and the less palatable to livestock.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Invaders. On range, plants that encroach into an area and grow after the climax vegetation has been reduced by grazing. Generally, invader plants are those that follow disturbance of the surface.

Large stones. Rock fragments 10 inches (25 centimeters) or more across. Large stones adversely affect the specified use.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.

Low strength. Inadequate strength for supporting loads.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Miscellaneous areas. Areas that have little or no natural soil, are too nearly inaccessible for orderly examination, or cannot otherwise be feasibly classified.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Neutral soil. A soil having a pH value between 6.6 and 7.3.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation. The downward movement of water through the soil.

Percs slowly. The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality that enables the soil to transmit water or air, measured as the number of inches per hour that water moves through the soil. Terms describing permeability are *very slow* (less than 0.06 inch), *slow* (0.06 to 0.20 inch), *moderately slow* (0.2 to 0.6 inch), *moderate* (0.6 to 2.0 inches), *moderately rapid* (2.0 to 6.0 inches), *rapid* (6.0 to 20 inches), and *very rapid* (more than 20 inches).

pH value. (See Reaction, soil). A numerical designation of acidity and alkalinity in soil.

Plastic limit. The moisture content at which a soil changes from a semisolid to a plastic state.

Productivity (soil). The capability of a soil for producing a specified plant or sequence of plants under a specified system of management. Productivity is measured in terms of output, or harvest, in relation to input.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Range (or rangeland). Land that, for the most part, produces native plants suitable for grazing by livestock; includes land supporting some forest trees.

Range condition. The health or productivity of forage plants on a given range, in terms of the potential productivity under normal climate and the best practical management. Condition classes generally recognized are—*excellent, good, fair,* and *poor*. The classification is based on the percentage of original, or assumed climax vegetation on a site, as compared to what has been observed to grow on it when well managed.

Range site. An area of range where climate, soil, and relief are sufficiently uniform to produce a distinct kind and amount of native vegetation.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH
Extremely acid	Below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Rooting depth. Shallow root zone. The soil is shallow over a layer that greatly restricts roots. See Root zone.

Root zone. The part of the soil that can be penetrated by plant roots.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sandstone. Sedimentary rock containing dominantly sand-size particles.

Seepage. The rapid movement of water through the soil. Seepage adversely affects the specified use.

Series, soil. A group of soils, formed from a particular type of parent material, having horizons that, except for the texture of the A or surface horizon, are similar in all profile characteristics and in arrangement in the soil profile. Among these characteristics are color, texture, structure, reaction, consistence, and mineralogical and chemical composition.

Shale. Sedimentary rock formed by the hardening of a clay deposit.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Site index. A designation of the quality of a forest site based on the height of the dominant stand at an arbitrarily chosen age. For example, if the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years is 75 feet, the site index is 75 feet.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Small stones. Rock fragments 3 to 10 inches (7.5 to 25 centimeters) in diameter. Small stones adversely affect the specified use.

Soil. A natural, three-dimensional body at the earth's surface that is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in mature soil consists of the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristics of the soil are largely confined to the solum.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates that are separated from adjoining aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grained* (each grain by itself,

as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Subsoiling. Tilling a soil below normal plow depth, ordinarily to shatter a hardpan or claypan.

Substratum. The part of the soil below the solum.

Subsurface layer. Any surface soil horizon (A1, A2, A3) below the surface layer.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently referred to as the "plow layer," or the "Ap horizon."

Surface soil. All of the A horizon.

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use or management.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that it can soak into the soil or flow slowly to a prepared outlet without harm. A terrace in a field is generally built so that the field can be farmed. A terrace intended mainly for drainage has a deep channel that is maintained in permanent sod.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea. A stream terrace is frequently called a second bottom, in contrast with a flood plain, and is seldom subject to overflow. A marine terrace, generally wide, was deposited by the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt, silt loam, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Tilth, soil. The condition of the soil, especially the soil structure, as related to the growth of plants. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

Toe slope. The outermost inclined surface at the base of a hill; part of a foot slope.

Topsoil (engineering). Presumably a fertile soil or soil material, or one that responds to fertilization, ordinarily rich in organic matter, used to topdress roadbanks, lawns, and gardens.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Water table. The upper limit of the soil or underlying rock material that is wholly saturated with water.

Water table, apparent. A thick zone of free water in the soil. An apparent water table is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil.

Water table, artesian. A water table under hydrostatic head, generally beneath an impermeable layer. When this layer is penetrated, the water level rises in an uncased borehole.

Water table, perched. A water table standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

ILLUSTRATIONS

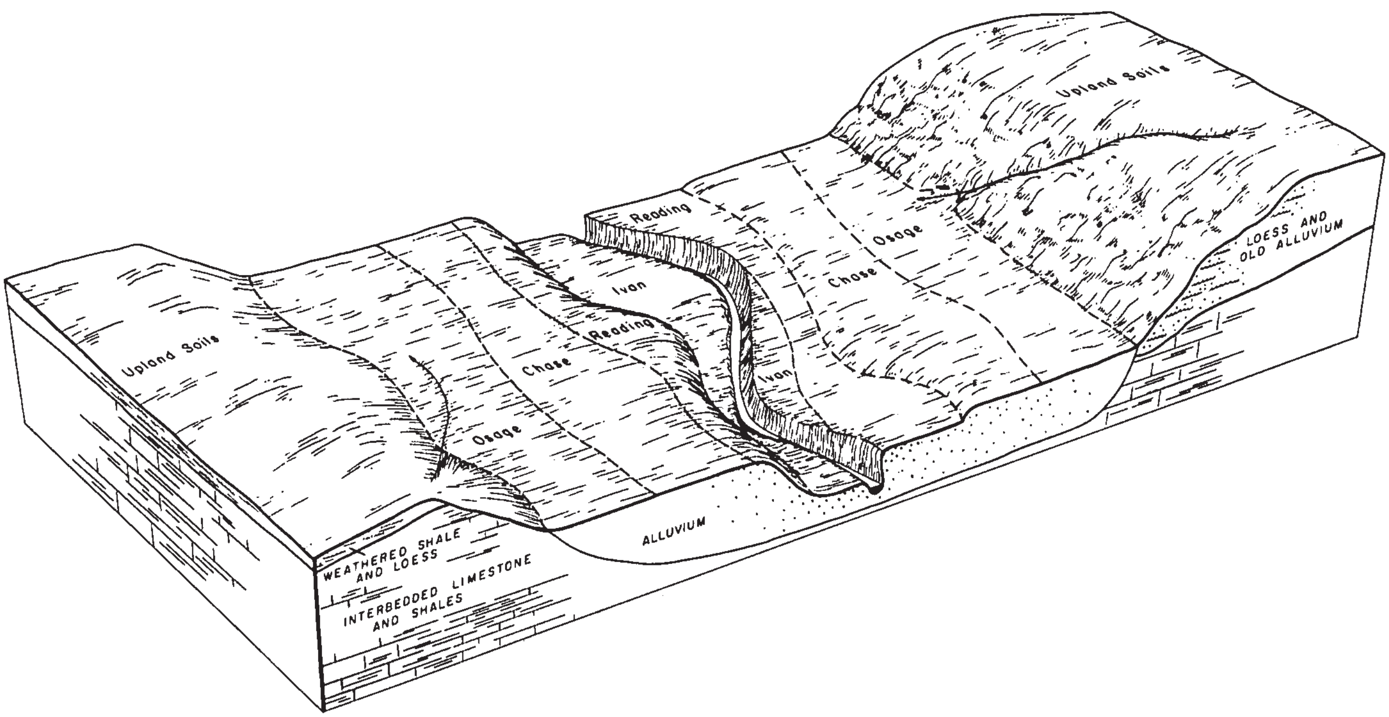

Figure 1.—Typical pattern of soils and underlying material in Chase-Osage association.

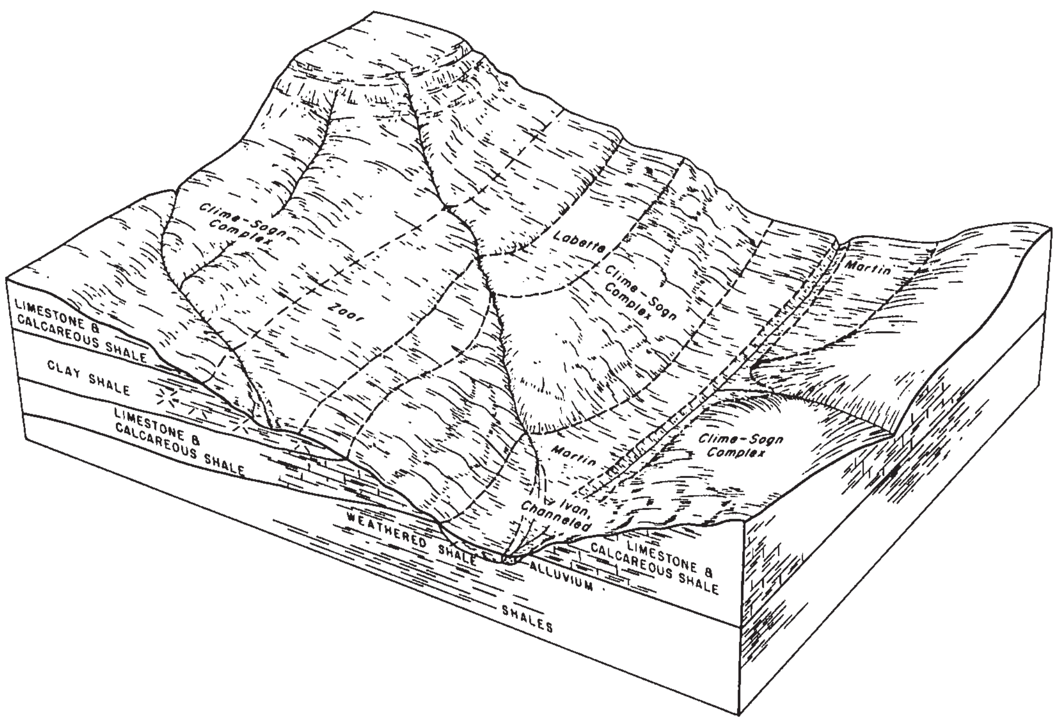

Figure 2.—Typical pattern of soils and underlying material in Clime-Sogn association.

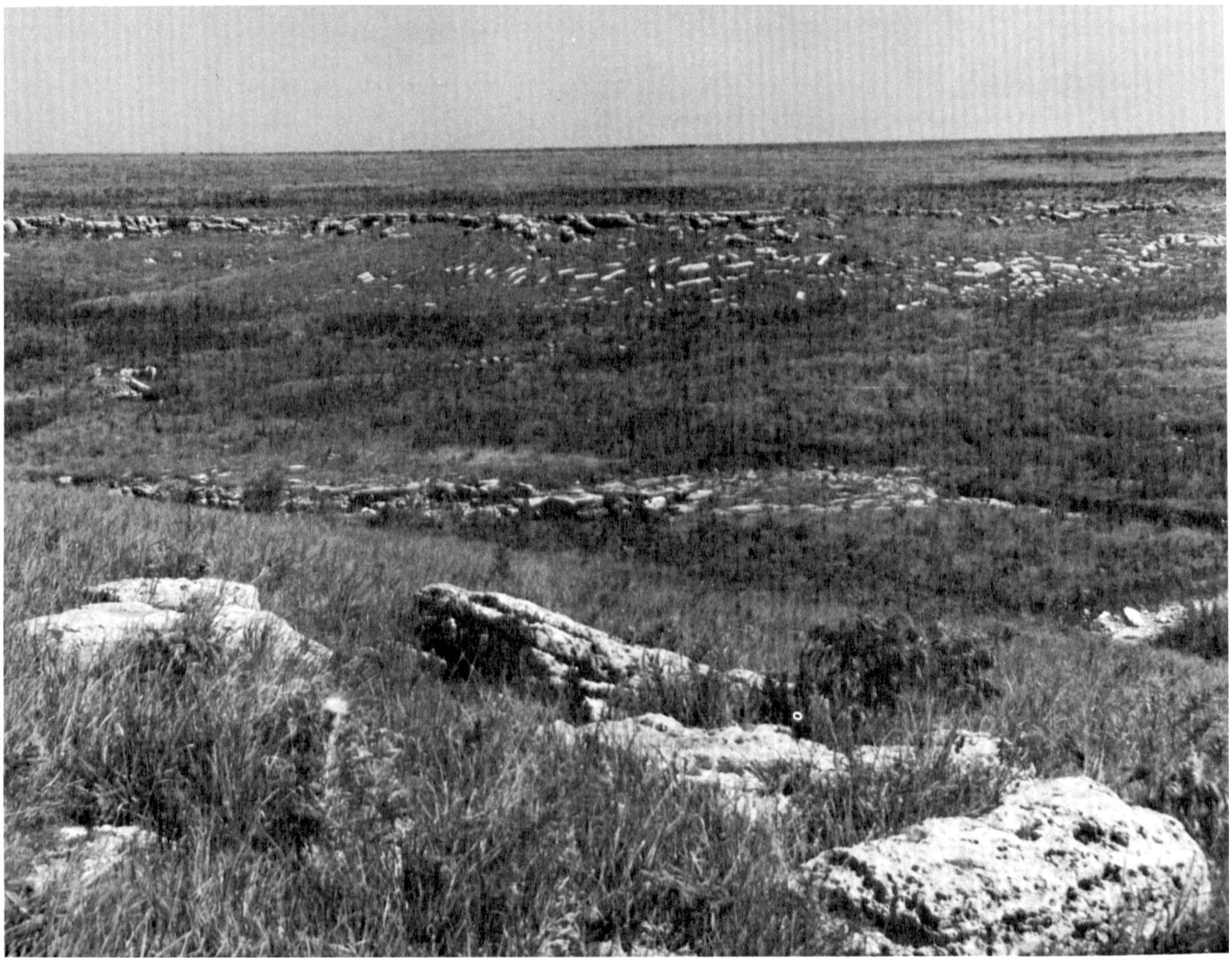

Figure 3.—Area of Clime-Sogn complex. Limestone rock is at the surface on Sogn silty clay loam. Clime silty clay is below the rock outcrop. Labette silty clay loam is in the background.

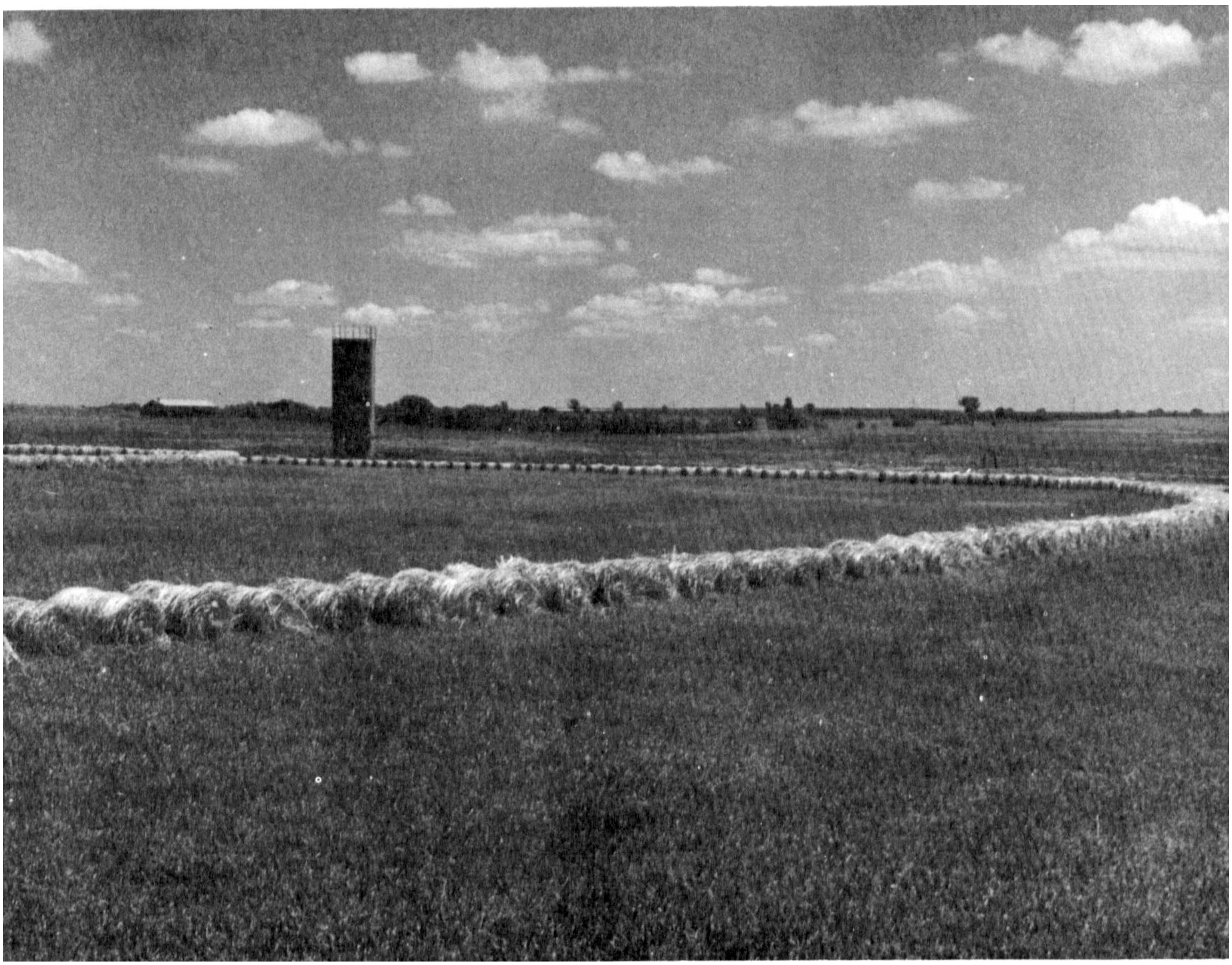

Figure 4.—Bales of bromegrass hay on terrace ridges provide feed for cattle in winter. The soil is Kenoma silt loam.

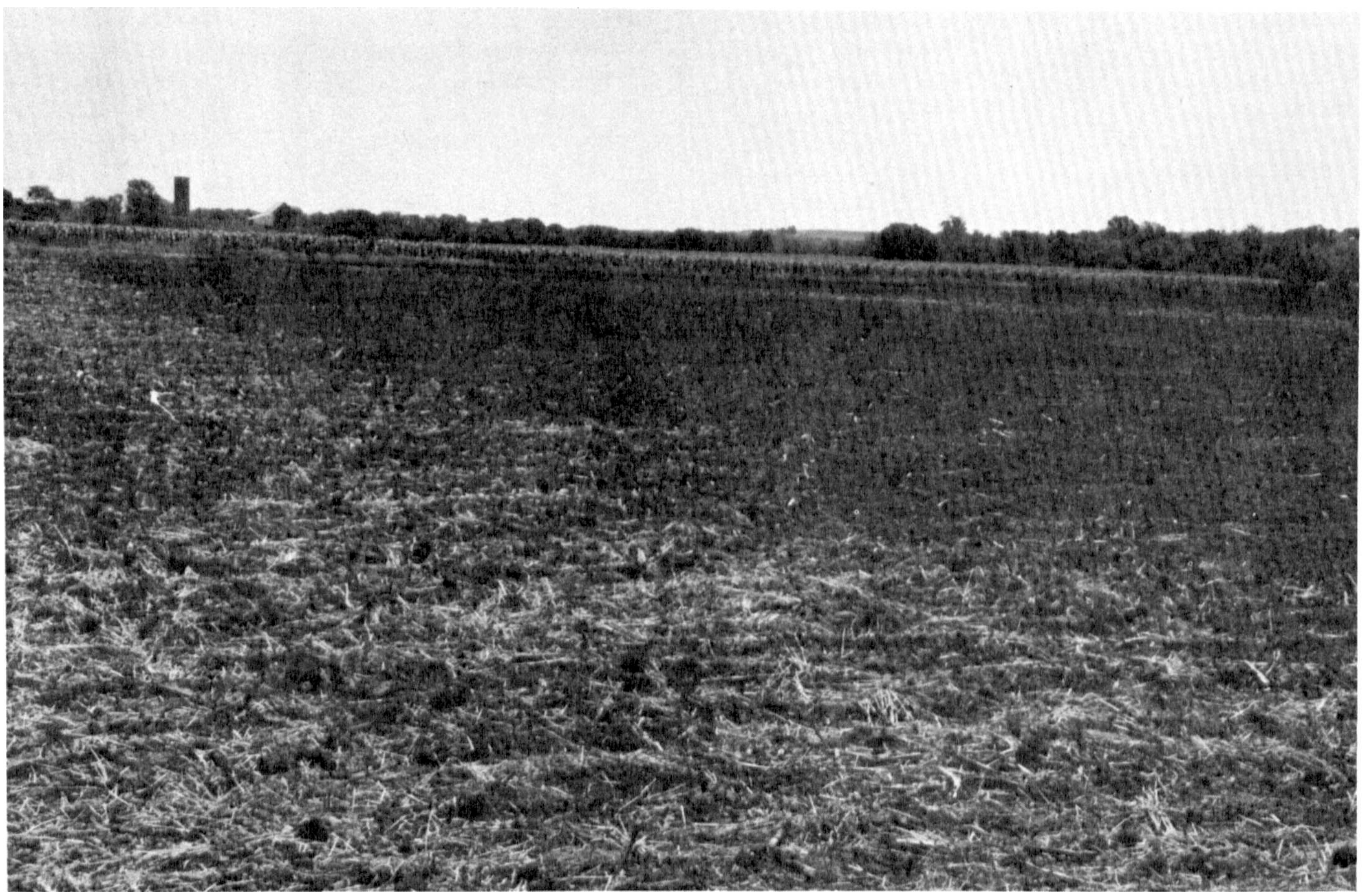

Figure 5.—Minimum tillage on Reading silt loam leaves part of the crop residue at the surface. In the background is a corn crop on Ivan silt loam.

Figure 6.—Profile of Florence cherty silt loam showing abundant cherty fragments below the dark colored Al horizon.

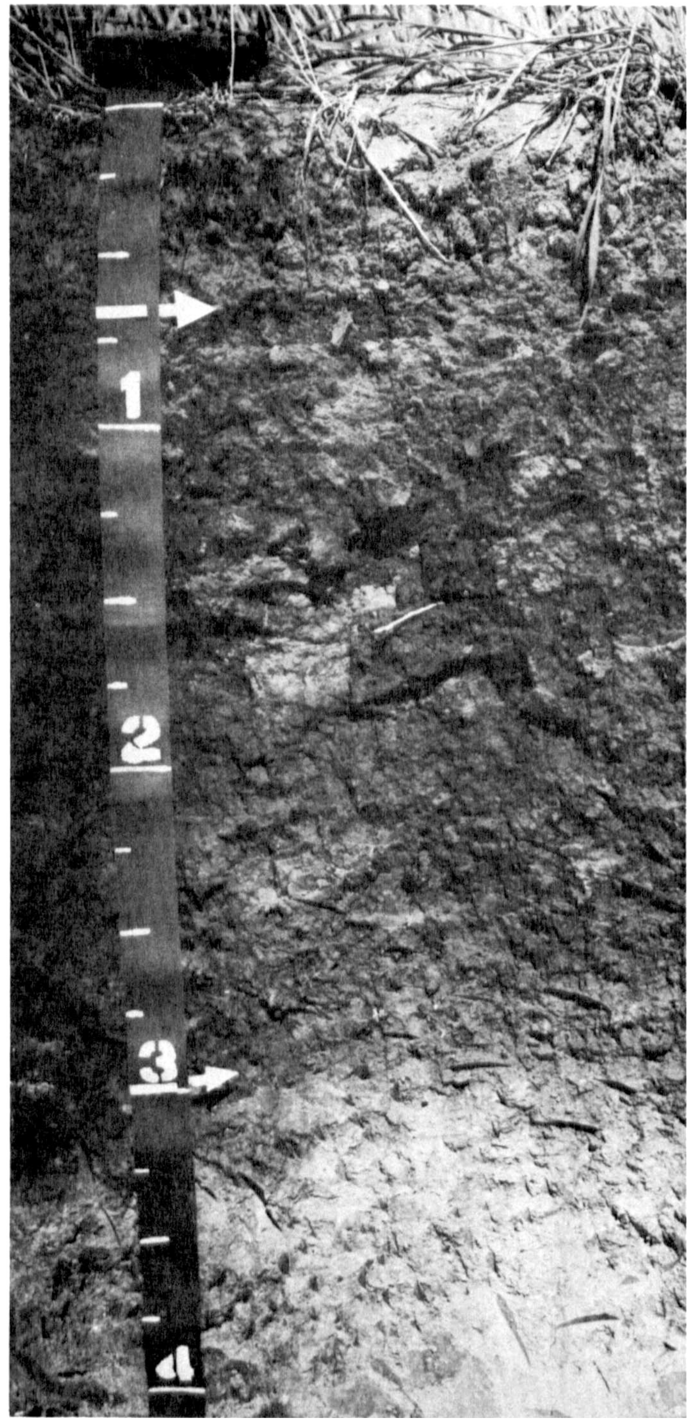

Figure 7.—Profile of Ladysmith silty clay loam. The dark colored B2t horizon extends to 37 inches.

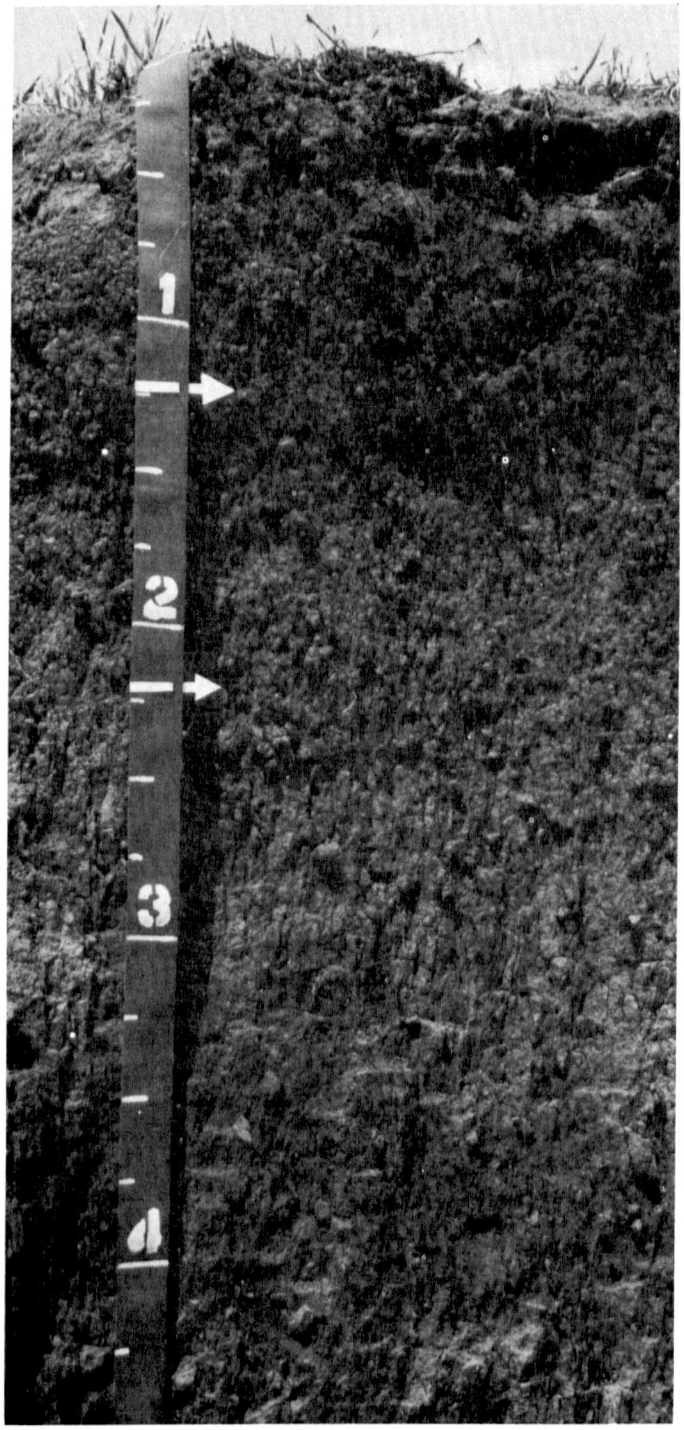

Figure 8.—Profile of Reading silt loam showing well developed subangular blocky structure in the B1 and B2t horizons.

TABLES

TABLE 1.--TEMPERATURE AND PRECIPITATION

Month	Temperature					Precipitation				
	Average daily maximum	Average daily minimum	Average daily	2 years in 10 will have-- Maximum temperature higher than--	2 years in 10 will have-- Minimum temperature lower than--	Average	2 years in 10 will have-- Less than--	2 years in 10 will have-- More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F	In	In	In		In
January----	39.6	18.1	28.9	71	- 9	0.68	0.16	1.11	2	4.2
February---	45.4	23.2	34.3	76	- 2	0.99	0.25	1.65	2	2.8
March------	53.3	29.5	41.4	85	1	2.14	1.28	3.28	4	3.1
April------	66.8	42.9	54.9	91	22	2.83	1.30	4.17	5	0.6
May--------	76.4	53.8	65.1	94	34	4.22	2.34	5.37	7	0.0
June-------	84.4	62.9	73.6	100	44	5.96	2.87	8.15	8	0.0
July-------	90.2	67.5	78.9	103	52	4.31	2.02	6.85	6	0.0
August-----	89.4	65.6	77.5	105	49	3.55	1.41	4.65	5	0.0
September--	81.1	56.7	69.0	100	40	4.43	1.34	7.01	6	0.0
October----	70.3	45.6	58.0	91	27	3.09	0.86	5.25	4	0.0
November---	54.8	32.0	43.4	76	8	1.39	0.08	2.55	2	0.6
December---	43.2	23.0	33.1	69	- 4	1.04	0.45	1.88	3	3.7
Year-----	66.2	43.4	54.8	105	- 9	34.63	23.38	43.54	54	15.0

TABLE 2.--FREEZE DATES IN SPRING AND FALL

Probability	Minimum temperature		
	24^{o} F or lower	28^{o} F or lower	32^{o} F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	April 9	April 20	May 2
2 years in 10 later than--	April 4	April 15	April 27
5 years in 10 later than--	March 26	April 5	April 17
First freezing temperature in fall:			
1 year in 10 earlier than--	October 22	October 16	October 7
2 years in 10 earlier than--	October 26	October 21	October 11
5 years in 10 earlier than--	November 5	October 30	October 21

TABLE 3.--GROWING SEASON

Probability	Daily minimum temperature during growing season		
	Higher than 24^{o} F	Higher than 28^{o} F	Higher than 32^{o} F
	Days	Days	Days
9 years in 10	203	188	166
8 years in 10	210	195	173
5 years in 10	224	208	187
2 years in 10	237	222	201
1 year in 10	245	229	208

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
Ba	Bates loam, 3 to 6 percent slopes	3,600	0.7
Bb	Bates loam, 3 to 6 percent slopes, eroded	2,400	0.4
Bc	Bates-Collinsville complex, 3 to 15 percent slopes	1,900	0.3
Ca	Chase silty clay loam	23,200	4.3
Cb	Clime silty clay, 3 to 7 percent slopes	7,700	1.4
Cc	Clime silty clay, 3 to 7 percent slopes, eroded	4,200	0.8
Cd	Clime-Sogn complex, 5 to 20 percent slopes	69,500	12.7
Ea	Elmont silt loam, 1 to 4 percent slopes	9,400	1.7
Eb	Elmont silt loam, 4 to 7 percent slopes	12,600	2.3
Ec	Elmont silty clay loam, 3 to 7 percent slopes, eroded	8,400	1.5
Ed	Eram silt loam, 3 to 6 percent slopes	9,300	1.7
Ee	Eram silty clay loam, 3 to 6 percent slopes, eroded	6,800	1.2
Ef	Eram and Bates soils, 6 to 15 percent slopes	5,900	1.1
Fa	Florence-Labette complex, 2 to 12 percent slopes	12,400	2.3
Ia	Ivan silt loam	29,300	5.4
Ib	Ivan silt loam, channeled	17,740	3.3
Ka	Kenoma silt loam, 1 to 3 percent slopes	104,900	19.4
Kb	Kenoma silty clay loam, 1 to 3 percent slopes, eroded	33,800	6.2
Kc	Kenoma silt loam, 3 to 6 percent slopes	7,100	1.3
Kd	Kenoma silty clay loam, 3 to 6 percent slopes, eroded	7,500	1.4
La	Labette silty clay loam, 1 to 3 percent slopes	11,600	2.1
Lb	Labette silty clay loam, 3 to 6 percent slopes	2,100	0.4
Lc	Labette silty clay loam, 2 to 6 percent slopes, eroded	2,300	0.4
Ld	Labette-Dwight complex, 0 to 2 percent slopes	17,500	3.2
Le	Ladysmith silty clay loam, 0 to 2 percent slopes	23,100	4.2
Ma	Martin silty clay loam, 1 to 4 percent slopes	10,250	1.9
Mb	Martin silty clay loam, 4 to 7 percent slopes	20,700	3.8
Mc	Martin silty clay, 3 to 7 percent slopes, eroded	9,900	1.8
Oa	Olpe-Kenoma complex, 3 to 15 percent slopes	9,800	1.8
Ob	Orthents, clayey	250	*
Oc	Osage silty clay	19,800	3.6
Ra	Reading silt loam	20,200	3.7
Ta	Tully silty clay loam, 2 to 7 percent slopes	2,600	0.5
Tb	Tully silty clay loam, 3 to 7 percent slopes, eroded	2,700	0.5
Tc	Tully-Clime complex, 7 to 15 percent slopes	3,400	0.6
Va	Vinland loam, 4 to 10 percent slopes	1,500	0.3
Za	Zaar silty clay, 2 to 5 percent slopes	2,900	0.5
	Water	7,040	1.3
	Total	545,280	100.0

* Less than 0.1 percent.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE

[Yields are those that can be expected under a high level of management. Absence of a yield indicates that the soil is not suited to the crop or the crop generally is not grown on the soil]

Soil name and map symbol	Corn	Winter wheat	Grain sorghum	Soybeans	Alfalfa hay	Smooth bromegrass
	Bu	Bu	Bu	Bu	Ton	AUM*
Ba----------------------- Bates	50	30	56	22	3.0	4.0
Bb----------------------- Bates	40	22	38	20	2.2	3.5
Ca----------------------- Chase	80	46	90	38	4.2	7.0
Cb----------------------- Clime	40	26	46	20	1.8	4.0
Cc----------------------- Clime	---	---	---	---	---	3.5
Ea----------------------- Elmont	75	42	82	36	3.6	6.5
Eb----------------------- Elmont	70	38	76	34	3.2	6.0
Ec----------------------- Elmont	65	34	64	32	3.0	5.5
Ed, Ee------------------- Eram	40	20	38	20	2.5	3.0
Ia----------------------- Ivan	75	38	72	34	4.0	7.0
Ka----------------------- Kenoma	60	36	70	30	3.0	5.0
Kb----------------------- Kenoma	50	30	60	26	2.6	4.0
Kc----------------------- Kenoma	55	30	62	26	2.6	4.5
Kd----------------------- Kenoma	45	26	50	22	2.2	3.5
La----------------------- Labette	60	36	62	32	3.0	5.5
Lb----------------------- Labette	55	34	58	30	2.8	5.0
Lc----------------------- Labette	50	28	52	26	2.2	4.0
Ld----------------------- Labette	55	30	50	28	2.2	4.5
Le----------------------- Ladysmith	50	38	64	30	3.0	5.0
Ma----------------------- Martin	72	40	80	36	3.2	6.0
Mb----------------------- Martin	65	36	74	32	2.8	5.5

See footnotes at end of table.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Corn	Winter wheat	Grain sorghum	Soybeans	Alfalfa hay	Smooth bromegrass
	Bu	Bu	Bu	Bu	Ton	AUM*
Mc------------------------ Martin	60	28	60	28	2.4	4.5
Ob**. Orthents						
Oc------------------------ Osage	---	28	57	25	---	2.4
Ra------------------------ Reading	85	48	92	40	4.4	7.5
Ta------------------------ Tully	65	38	70	32	3.0	5.5
Tb------------------------ Tully	60	32	60	28	2.6	4.5
Za------------------------ Zaar	55	34	58	26	2.0	5.5

* Animal-unit-month: The amount of forage or feed required to feed one animal unit (one cow, one horse, one mule, five sheep, or five goats) for 30 days.

** See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 6.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES

[Only the soils that support rangeland vegetation suitable for grazing are listed]

Soil name and map symbol	Range site name	Total production: Kind of year	Total production: Dry weight	Characteristic vegetation	Composition
			Lb/acre		Pct
Ba, Bb: Bates	Loamy Upland	Favorable	7,000	Big bluestem	35
		Normal	5,500	Little bluestem	25
		Unfavorable	4,500	Indiangrass	10
				Switchgrass	5
				Leadplant	5
Bc*:					
Bates	Loamy Upland	Favorable	7,000	Big bluestem	35
		Normal	5,500	Little bluestem	25
		Unfavorable	4,500	Indiangrass	10
				Switchgrass	5
				Leadplant	5
Collinsville	Shallow Sandstone	Favorable	3,500	Little bluestem	30
		Normal	2,300	Big bluestem	15
		Unfavorable	1,500	Indiangrass	10
				Switchgrass	10
				Sideoats grama	10
				Tall dropseed	5
				Longspike tridens	5
				Pale echinacea	5
				Heath aster	5
Ca: Chase	Loamy Lowland	Favorable	10,000	Big bluestem	40
		Normal	8,000	Indiangrass	10
		Unfavorable	6,000	Switchgrass	10
				Eastern gamagrass	10
				Prairie cordgrass	5
Cb, Cc: Clime	Limy Upland	Favorable	5,000	Little bluestem	30
		Normal	3,500	Big bluestem	20
		Unfavorable	2,500	Sideoats grama	15
				Indiangrass	5
				Switchgrass	5
				Leadplant	5
Cd*:					
Clime	Limy Upland	Favorable	5,000	Little bluestem	30
		Normal	3,500	Big bluestem	20
		Unfavorable	2,500	Sideoats grama	15
				Indiangrass	5
				Switchgrass	5
				Leadplant	5
Sogn	Shallow Limy	Favorable	3,500	Sideoats grama	20
		Normal	2,500	Little bluestem	20
		Unfavorable	1,500	Big bluestem	20
				Indiangrass	5
				Switchgrass	5
				Tall dropseed	5
Ea, Eb, Ec: Elmont	Loamy Upland	Favorable	7,000	Big bluestem	30
		Normal	5,500	Little bluestem	20
		Unfavorable	4,000	Indiangrass	15
				Switchgrass	5
				Tall dropseed	5
				Compassplant	5
Ed, Ee: Eram	Clay Upland	Favorable	6,000	Big bluestem	30
		Normal	4,200	Little bluestem	15
		Unfavorable	3,000	Switchgrass	15
				Indiangrass	10
				Tall dropseed	5

See footnote at end of table.

TABLE 6.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES--Continued

Soil name and map symbol	Range site name	Total production: Kind of year	Total production: Dry weight	Characteristic vegetation	Composition
			Lb/acre		Pct
Ef*:					
Eram	Clay Upland	Favorable	6,000	Big bluestem	30
		Normal	4,200	Little bluestem	15
		Unfavorable	3,000	Switchgrass	15
				Indiangrass	10
				Tall dropseed	5
Bates	Loamy Upland	Favorable	7,000	Big bluestem	35
		Normal	5,500	Little bluestem	25
		Unfavorable	4,500	Indiangrass	10
				Switchgrass	5
				Leadplant	5
Fa*:					
Florence	Loamy Upland	Favorable	6,000	Big bluestem	35
		Normal	5,000	Little bluestem	25
		Unfavorable	4,000	Indiangrass	10
				Switchgrass	5
				Sideoats grama	5
Labette	Loamy Upland	Favorable	6,000	Big bluestem	30
		Normal	5,000	Little bluestem	20
		Unfavorable	4,000	Indiangrass	20
				Switchgrass	10
				Compassplant	5
Ia, Ib Ivan	Loamy Lowland	Favorable	10,000	Big bluestem	40
		Normal	8,000	Indiangrass	15
		Unfavorable	6,000	Switchgrass	10
				Eastern gamagrass	9
				Little bluestem	5
				Prairie cordgrass	5
Ka, Kb, Kc, Kd Kenoma	Clay Upland	Favorable	6,000	Big bluestem	25
		Normal	4,500	Little bluestem	20
		Unfavorable	2,500	Indiangrass	15
				Switchgrass	15
				Tall dropseed	5
				Sideoats grama	5
La, Lb, Lc Labette	Loamy Upland	Favorable	6,000	Big bluestem	30
		Normal	5,000	Little bluestem	20
		Unfavorable	4,000	Indiangrass	20
				Switchgrass	10
				Compassplant	5
Ld*:					
Labette	Loamy Upland	Favorable	6,000	Big bluestem	30
		Normal	5,000	Little bluestem	20
		Unfavorable	4,000	Indiangrass	20
				Switchgrass	10
				Compassplant	5
Dwight	Claypan	Favorable	4,000	Big bluestem	15
		Normal	3,000	Little bluestem	10
		Unfavorable	2,000	Prairie dropseed	10
				Tall dropseed	10
				Heath aster	10
				Western wheatgrass	10
				Blue grama	10
				Switchgrass	5
				Sideoats grama	5
				Western ragweed	5

See footnote at end of table.

TABLE 6.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES--Continued

Soil name and map symbol	Range site name	Total production: Kind of year	Total production: Dry weight	Characteristic vegetation	Composition
			Lb/acre		Pct
Le: Ladysmith	Clay Upland	Favorable	6,000	Big bluestem	25
		Normal	4,000	Little bluestem	20
		Unfavorable	2,000	Indiangrass	15
				Switchgrass	15
				Tall dropseed	5
				Sideoats grama	5
Ma, Mb, Mc: Martin	Loamy Upland	Favorable	7,000	Big bluestem	30
		Normal	5,500	Little bluestem	15
		Unfavorable	4,000	Indiangrass	10
				Switchgrass	10
				Tall dropseed	5
				Sideoats grama	5
				Leadplant	5
Oa*:					
Olpe	Loamy Upland	Favorable	7,000	Big bluestem	30
		Normal	5,500	Little bluestem	20
		Unfavorable	4,000	Indiangrass	15
				Switchgrass	10
				Leadplant	5
				Tall dropseed	5
Kenoma	Clay Upland	Favorable	6,000	Big bluestem	25
		Normal	4,500	Little bluestem	20
		Unfavorable	2,500	Indiangrass	15
				Switchgrass	15
				Tall dropseed	5
				Sideoats grama	5
Oc: Osage	Clay Lowland	Favorable	9,000	Switchgrass	25
		Normal	8,000	Indiangrass	15
		Unfavorable	6,000	Big bluestem	15
				Eastern gamagrass	10
				Little bluestem	10
				Prairie cordgrass	10
Ra: Reading	Loamy Lowland	Favorable	10,000	Big bluestem	40
		Normal	8,000	Indiangrass	10
		Unfavorable	6,000	Switchgrass	10
				Eastern gamagrass	10
				Prairie cordgrass	5
Ta, Tb: Tully	Loamy Upland	Favorable	6,000	Big bluestem	30
		Normal	5,000	Little bluestem	15
		Unfavorable	4,000	Switchgrass	10
				Indiangrass	10
				Leadplant	6
				Tall dropseed	5
				Sideoats grama	5
Tc*:					
Tully	Loamy Upland	Favorable	6,000	Big bluestem	30
		Normal	5,000	Little bluestem	15
		Unfavorable	4,000	Switchgrass	10
				Indiangrass	10
				Leadplant	6
				Tall dropseed	5
				Sideoats grama	5

See footnote at end of table.

TABLE 6.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES--Continued

Soil name and map symbol	Range site name	Total production: Kind of year	Total production: Dry weight	Characteristic vegetation	Composition
			Lb/acre		Pct
Tc*:					
Clime	Limy Upland	Favorable	5,000	Little bluestem	30
		Normal	3,500	Big bluestem	20
		Unfavorable	2,500	Sideoats grama	15
				Indiangrass	5
				Switchgrass	5
				Leadplant	5
Va- Vinland	Loamy Upland	Favorable	4,000	Big bluestem	25
		Normal	3,000	Little bluestem	25
		Unfavorable	2,000	Indiangrass	10
				Switchgrass	10
				Leadplant	5
Za- Zaar	Clay Upland	Favorable	6,000	Big bluestem	25
		Normal	4,500	Little bluestem	20
		Unfavorable	2,500	Indiangrass	15
				Switchgrass	15
				Tall dropseed	5
				Sideoats grama	5

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS

[The symbol < means less than; > means more than. Absence of an entry indicates that trees generally do not grow to the given height on that soil]

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of-- <8	8-15	16-25	26-35	>35
Ba, Bb: Bates	Fragrant sumac, lilac.	Amur maple	Russian mulberry, green ash, honeylocust, common hackberry.	Scotch pine, Austrian pine.	---
Bc*: Bates	Fragrant sumac, lilac.	Amur maple	Russian mulberry	Scotch pine, Austrian pine.	---
Collinsville.**					
Ca: Chase	Fragrant sumac	Amur honeysuckle, lilac.	Russian mulberry, eastern redcedar.	Common hackberry, green ash.	Eastern cottonwood, silver maple.
Cb, Cc: Clime	Fragrant sumac, lilac.	Eastern redcedar	Russian mulberry, common hackberry, green ash.	---	---
Cd*: Clime	Fragrant sumac, lilac.	---	Russian mulberry, common hackberry, green ash.	---	---
Sogn.**					
Ea, Eb, Ec: Elmont	Fragrant sumac, lilac.	Amur maple	Russian mulberry, honeylocust, common hackberry, green ash.	Austrian pine, Scotch pine.	---
Ed, Ee: Eram	Fragrant sumac, lilac.	Eastern redcedar	Green ash, Russian mulberry, common hackberry.	---	---
Ef*: Eram	Fragrant sumac, lilac.	Eastern redcedar	Green ash, Russian mulberry, common hackberry.	---	---
Bates	Fragrant sumac, lilac.	Amur maple	Russian mulberry, common hackberry, green ash, honeylocust.	Scotch pine, Austrian pine.	---
Fa*: Florence.**					
Labette	Fragrant sumac, lilac.	Amur maple	Eastern redcedar, honeylocust, common hackberry, green ash.	Austrian pine, Scotch pine.	---
Ia, Ib: Ivan	Fragrant sumac	Amur honeysuckle, lilac.	Eastern redcedar, Russian mulberry.	Common hackberry, green ash.	Eastern cottonwood silver maple.
Ka, Kb, Kc, Kd: Kenoma	Fragrant sumac	Eastern redcedar	Common hackberry, Russian-olive, pin oak.	Green ash, Austrian pine, Siberian elm.	---
La, Lb, Lc: Labette	Fragrant sumac, lilac.	Amur maple	Eastern redcedar, common hackberry, green ash, honeylocust.	Austrian pine, Scotch pine.	---

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
Ld*:					
Labette	Fragrant sumac, lilac.	Amur maple	Honeylocust, common hackberry, green ash, eastern redcedar.	Austrian pine, Scotch pine.	---
Dwight	Silver buffalo-berry.	Russian-olive	Eastern redcedar, green ash, honeylocust.	Golden willow	Eastern cottonwood.
Le Ladysmith	Fragrant sumac	Eastern redcedar	Common hackberry, pin oak, Russian-olive.	Green ash, Austrian pine, Siberian elm.	---
Ma, Mb, Mc Martin	Peking cotoneaster, fragrant sumac.	Amur maple	Green ash, common hackberry, Austrian pine, eastern redcedar.	Honeylocust, ponderosa pine.	---
Oa*:					
Olpe.**					
Kenoma	Fragrant sumac	Eastern redcedar	Common hackberry, Russian-olive, pin oak.	Green ash, Austrian pine, Siberian elm.	---
Ob*. Orthents					
Oc Osage	---	Amur honeysuckle, redosier dogwood.	Eastern redcedar	Green ash, honeylocust.	Eastern cottonwood, silver maple.
Ra Reading	Fragrant sumac	American plum, Amur honeysuckle, lilac.	Eastern redcedar, Russian mulberry.	Common hackberry, green ash.	Eastern cottonwood, silver maple.
Ta, Tb Tully	Fragrant sumac, lilac.	---	Common hackberry, eastern redcedar, honeylocust, green ash.	Austrian pine, Scotch pine.	---
Tc*:					
Tully	Fragrant sumac, lilac.	---	Common hackberry, eastern redcedar, honeylocust, green ash.	Austrian pine, Scotch pine.	---
Clime	Fragrant sumac, lilac.	Eastern redcedar	Russian mulberry, common hackberry, green ash.	---	---
Va.** Vinland					
Za Zaar	Fragrant sumac	Amur maple	Eastern redcedar, Austrian pine, Russian-olive, common hackberry.	Green ash	---

* See description of the map unit for composition and behavior characteristics of the map unit.
** This soil generally is not suited to windbreaks.

TABLE 8.--BUILDING SITE DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
Ba, Bb------------ Bates	Moderate: depth to rock.	Slight-----------	Moderate: depth to rock.	Moderate: slope.	Moderate: low strength.
Bc*:					
Bates------------	Moderate: depth to rock.	Slight-----------	Moderate: depth to rock.	Moderate: slope.	Moderate: low strength.
Collinsville-----	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock, slope.	Severe: depth to rock.
Ca---------------- Chase	Severe: wetness, floods.	Severe: floods, shrink-swell.	Severe: floods, shrink-swell.	Severe: floods, shrink-swell.	Severe: shrink-swell, low strength, floods.
Cb, Cc------------ Clime	Moderate: too clayey, depth to rock.	Moderate: shrink-swell.	Moderate: shrink-swell, depth to rock.	Moderate: shrink-swell slope.	Severe: low strength.
Cd*:					
Clime------------	Moderate: too clayey, slope, depth to rock.	Moderate: shrink-swell, slope.	Moderate: shrink-swell, depth to rock, slope.	Severe: slope.	Severe: low strength.
Sogn-------------	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.
Ea---------------- Elmont	Slight-----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.
Eb, Ec------------ Elmont	Slight-----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.
Ed, Ee------------ Eram	Moderate: too clayey, wetness, depth to rock.	Severe: shrink-swell.	Severe: shrink-swell, wetness.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Ef*:					
Eram-------------	Moderate: too clayey, wetness, depth to rock.	Severe: shrink-swell.	Severe: shrink-swell, wetness.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Bates------------	Moderate: depth to rock.	Slight-----------	Moderate: depth to rock.	Moderate: slope.	Moderate: low strength.
Fa*:					
Florence---------	Severe: large stones.	Severe: large stones.	Severe: large stones.	Severe: large stones.	Severe: large stones, low strength.
Labette----------	Severe: depth to rock.	Severe: shrink-swell.	Severe: shrink-swell, depth to rock.	Severe: shrink-swell.	Severe: shrink-swell, low strength.
Ia, Ib------------ Ivan	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods, low strength.

See footnote at end of table.

TABLE 8.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
Ka, Kb, Kc, Kd----- Kenoma	Moderate: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, low strength.
La, Lb, Lc--------- Labette	Severe: depth to rock.	Severe: shrink-swell.	Severe: shrink-swell, depth to rock.	Severe: shrink-swell.	Severe: shrink-swell, low strength.
Ld*:					
Labette-----------	Severe: depth to rock.	Severe: shrink-swell.	Severe: shrink-swell, depth to rock.	Severe: shrink-swell.	Severe: shrink-swell, low strength.
Dwight------------	Moderate: too clayey, depth to rock.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Le----------------- Ladysmith	Moderate: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Ma, Mb, Mc--------- Martin	Moderate: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Oa*:					
Olpe--------------	Moderate: too clayey, slope.	Moderate: shrink-swell, slope.	Moderate: shrink-swell, slope.	Severe: slope.	Moderate: shrink-swell, slope.
Kenoma------------	Moderate: too clayey, slope.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, low strength.
Ob*. Orthents					
Oc----------------- Osage	Severe: floods, wetness.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.	Severe: wetness, low strength, floods.
Ra----------------- Reading	Moderate: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: low strength.
Ta, Tb------------- Tully	Moderate: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, low strength.
Tc*:					
Tully-------------	Moderate: too clayey, slope.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, slope.	Severe: shrink-swell, low strength.
Clime-------------	Moderate: too clayey, slope, depth to rock.	Moderate: shrink-swell, slope.	Moderate: shrink-swell, slope, depth to rock.	Severe: slope.	Severe: low strength.
Va----------------- Vinland	Severe: depth to rock.	Moderate: depth to rock.	Severe: depth to rock.	Moderate: depth to rock, slope.	Moderate: depth to rock.

See footnote at end of table.

TABLE 8.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
Za: Zaar	Severe: wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, low strength.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--SANITARY FACILITIES

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," "good," "fair," and other terms. Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Ba, Bb: Bates	Severe: depth to rock.	Moderate: depth to rock, slope, seepage.	Severe: depth to rock.	Moderate: depth to rock.	Poor: area reclaim.
Bc*:					
Bates	Severe: depth to rock.	Moderate: depth to rock, slope, seepage.	Severe: depth to rock.	Moderate: depth to rock.	Poor: area reclaim.
Collinsville	Severe: depth to rock.	Severe: seepage, depth to rock, slope.	Severe: seepage, depth to rock.	Severe: seepage, depth to rock.	Poor: area reclaim.
Ca: Chase	Severe: floods, percs slowly, wetness.	Severe: floods.	Severe: floods, too clayey, wetness.	Severe: floods.	Poor: too clayey.
Cb, Cc: Clime	Severe: percs slowly, depth to rock.	Moderate: depth to rock, slope.	Severe: too clayey, depth to rock.	Moderate: depth to rock.	Poor: too clayey, area reclaim.
Cd*:					
Clime	Severe: percs slowly, depth to rock.	Severe: slope.	Severe: too clayey, depth to rock.	Moderate: slope, depth to rock.	Poor: too clayey, area reclaim.
Sogn	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim.
Ea, Eb, Ec: Elmont	Severe: percs slowly.	Moderate: slope.	Severe: depth to rock.	Slight	Fair: too clayey.
Ed, Ee: Eram	Severe: percs slowly, wetness, depth to rock.	Moderate: depth to rock, slope.	Severe: too clayey, depth to rock.	Moderate: wetness, depth to rock.	Poor: area reclaim.
Ef*:					
Eram	Severe: percs slowly, wetness, depth to rock.	Severe: slope.	Severe: too clayey, depth to rock.	Moderate: wetness, depth to rock, slope.	Poor: area reclaim.
Bates	Severe: depth to rock.	Severe: slope.	Severe: depth to rock, slope.	Moderate: depth to rock, slope.	Poor: area reclaim.
Fa*:					
Florence	Severe: percs slowly, depth to rock.	Severe: large stones, slope.	Severe: depth to rock.	Slight	Poor: small stones, large stones.
Labette	Severe: depth to rock, percs slowly.	Severe: depth to rock.	Severe: depth to rock.	Moderate: depth to rock.	Poor: area reclaim.
Ia, Ib: Ivan	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Good.

See footnote at end of table.

TABLE 9.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Ka, Kb, Kc, Kd------ Kenoma	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight-----------	Poor: too clayey.
La, Lb, Lc---------- Labette	Severe: depth to rock, percs slowly.	Severe: depth to rock.	Severe: depth to rock.	Moderate: depth to rock.	Poor: area reclaim, too clayey.
Ld*:					
Labette------------	Severe: depth to rock, percs slowly.	Severe: depth to rock.	Severe: depth to rock.	Moderate: depth to rock.	Poor: area reclaim, too clayey.
Dwight-------------	Severe: percs slowly, depth to rock.	Moderate: depth to rock.	Severe: too clayey, depth to rock.	Slight-----------	Poor: too clayey.
Le------------------ Ladysmith	Severe: percs slowly.	Slight-----------	Severe: too clayey.	Slight-----------	Poor: too clayey.
Ma, Mb, Mc---------- Martin	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight-----------	Poor: too clayey.
Oa*:					
Olpe---------------	Severe: percs slowly.	Severe: slope.	Severe: too clayey.	Moderate: slope.	Poor: small stones.
Kenoma-------------	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight-----------	Poor: too clayey.
Ob*. Orthents					
Oc------------------ Osage	Severe: floods, percs slowly, wetness.	Severe: floods.	Severe: floods, wetness, too clayey.	Severe: floods, wetness.	Poor: wetness, too clayey.
Ra------------------ Reading	Severe: percs slowly.	Moderate: seepage.	Moderate: floods, too clayey.	Moderate: floods.	Fair: too clayey.
Ta, Tb-------------- Tully	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight-----------	Poor: too clayey.
Tc*:					
Tully--------------	Severe: percs slowly.	Severe: slope.	Severe: too clayey.	Moderate: slope.	Poor: too clayey.
Clime--------------	Severe: percs slowly, depth to rock.	Severe: slope.	Severe: too clayey, depth to rock.	Moderate: slope, depth to rock.	Poor: too clayey, area reclaim.
Va------------------ Vinland	Severe: depth to rock.	Severe: depth to rock, slope.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim.
Za------------------ Zaar	Severe: percs slowly, wetness.	Moderate: slope.	Severe: too clayey, wetness.	Severe: wetness.	Poor: too clayey.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--CONSTRUCTION MATERIALS

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," and "poor." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Ba, Bb------------------ Bates	Poor: thin layer, area reclaim.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: area reclaim.
Bc*:				
Bates------------------	Poor: thin layer, area reclaim.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: area reclaim.
Collinsville----------	Poor: thin layer, area reclaim.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: thin layer.
Ca--------------------- Chase	Poor: low strength, shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer, too clayey.
Cb, Cc----------------- Clime	Poor: low strength, area reclaim.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: too clayey.
Cd*:				
Clime------------------	Poor: low strength, area reclaim.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: too clayey.
Sogn-------------------	Poor: thin layer, area reclaim.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: thin layer.
Ea, Eb----------------- Elmont	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.
Ec--------------------- Elmont	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey.
Ed--------------------- Eram	Poor: low strength, shrink-swell, thin layer.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.
Ee--------------------- Eram	Poor: low strength, shrink-swell, thin layer.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer, too clayey.
Ef*:				
Eram-------------------	Poor: low strength, shrink-swell, thin layer.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.
Bates------------------	Poor: thin layer, area reclaim.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: area reclaim.
Fa*:				
Florence--------------	Poor: low strength, large stones.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: small stones, large stones.

See footnote at end of table.

TABLE 10.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Fa*:				
Labette	Poor: shrink-swell, low strength, area reclaim.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer, too clayey, area reclaim.
Ia, Ib Ivan	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
Ka, Kb, Kc, Kd Kenoma	Poor: shrink-swell, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: thin layer.
La, Lb, Lc Labette	Poor: shrink-swell, low strength, area reclaim.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer, too clayey, area reclaim.
Ld*:				
Labette	Poor: shrink-swell, low strength, area reclaim.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer, too clayey, area reclaim.
Dwight	Poor: low strength, shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: thin layer.
Le Ladysmith	Poor: low strength, shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer, too clayey.
Ma, Mb Martin	Poor: low strength, shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey.
Mc Martin	Poor: low strength, shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: too clayey.
Oa*:				
Olpe	Fair: shrink-swell, low strength.	Unsuited: excess fines.	Poor: excess fines.	Poor: small stones.
Kenoma	Poor: shrink-swell, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: thin layer.
Ob*. Orthents				
Oc Osage	Poor: wetness, low strength, shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: too clayey, wetness.
Ra Reading	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.
Ta, Tb Tully	Poor: low strength, shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey.
Tc*:				
Tully	Poor: low strength, shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey, slope.

See footnote at end of table.

TABLE 10.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Tc*:				
Clime	Poor: low strength, area reclaim.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: too clayey.
Va- Vinland	Poor: thin layer, area reclaim.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: area reclaim.
Za- Zaar	Poor: low strength, shrink-swell, wetness.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: too clayey.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--WATER MANAGEMENT

[Some terms that describe restrictive soil features are defined in the Glossary. Absence of an entry indicates that the soil was not evaluated]

Soil name and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Ba, Bb----------- Bates	Depth to rock, seepage.	Thin layer, piping.	Not needed-----	Rooting depth	Depth to rock	Depth to rock.
Bc*:						
Bates------------	Depth to rock, seepage.	Thin layer, piping.	Not needed-----	Rooting depth	Depth to rock	Depth to rock.
Collinsville-----	Seepage, depth to rock.	Thin layer-----	Not needed-----	Rooting depth	Depth to rock	Droughty, rooting depth.
Ca---------------- Chase	Favorable------	Hard to pack, wetness.	Floods, percs slowly.	Percs slowly, floods.	Not needed-----	Percs slowly.
Cb, Cc------------ Clime	Depth to rock	Thin layer, hard to pack.	Not needed-----	Slow intake, percs slowly, rooting depth.	Depth to rock, percs slowly.	Depth to rock, percs slowly.
Cd*:						
Clime------------	Slope, depth to rock.	Thin layer, hard to pack.	Not needed-----	Slow intake, percs slowly, rooting depth.	Slope, depth to rock, percs slowly.	Slope, depth to rock, percs slowly.
Sogn-------------	Depth to rock	Thin layer-----	Not needed-----	Rooting depth, droughty.	Depth to rock	Droughty, rooting depth.
Ea, Eb, Ec-------- Elmont	Depth to rock	Thin layer-----	Not needed-----	Favorable------	Erodes easily	Erodes easily.
Ed, Ee------------ Eram	Depth to rock	Thin layer, hard to pack, wetness.	Percs slowly, depth to rock.	Percs slowly, rooting depth, wetness.	Percs slowly---	Percs slowly, erodes easily.
Ef*:						
Eram-------------	Depth to rock	Thin layer, hard to pack, wetness.	Percs slowly, depth to rock.	Percs slowly, rooting depth, wetness.	Percs slowly---	Percs slowly, erodes easily.
Bates------------	Slope, depth to rock, seepage.	Thin layer, piping.	Not needed-----	Rooting depth, slope.	Depth to rock	Depth to rock.
Fa*:						
Florence---------	Slope, depth to rock.	Thin layer, hard to pack, large stones.	Not needed-----	Slope, large stones, droughty.	Large stones---	Large stones, droughty.
Labette----------	Depth to rock	Thin layer, hard to pack.	Not needed-----	Percs slowly, rooting depth, erodes easily.	Large stones, depth to rock, percs slowly.	Erodes easily, depth to rock.
Ia, Ib------------ Ivan	Seepage--------	Favorable------	Not needed-----	Floods---------	Not needed-----	Favorable.
Ka, Kb, Kc, Kd---- Kenoma	Favorable------	Hard to pack---	Not needed-----	Erodes easily, percs slowly.	Erodes easily, percs slowly.	Percs slowly, erodes easily.
La, Lb, Lc-------- Labette	Depth to rock	Thin layer, hard to pack.	Not needed-----	Percs slowly, rooting depth, erodes easily.	Large stones, depth to rock, percs slowly.	Erodes easily, depth to rock.
Ld*:						
Labette----------	Depth to rock	Thin layer, hard to pack.	Not needed-----	Percs slowly, rooting depth, erodes easily.	Not needed-----	Erodes easily, depth to rock.

See footnote at end of table.

TABLE 11.--WATER MANAGEMENT--Continued

Soil name and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Ld*:						
Dwight	Depth to rock	Hard to pack, thin layer.	Percs slowly, excess sodium.	Percs slowly, excess sodium, erodes easily.	Not needed	Percs slowly, excess sodium.
Le Ladysmith	Favorable	Hard to pack	Not needed	Percs slowly, erodes easily.	Not needed	Percs slowly, erodes easily.
Ma, Mb Martin	Favorable	Hard to pack	Not needed	Percs slowly, erodes easily.	Percs slowly	Erodes easily, percs slowly.
Mc Martin	Favorable	Hard to pack	Not needed	Percs slowly, erodes easily, slow intake.	Percs slowly	Erodes easily, percs slowly.
Oa*:						
Olpe	Slope	Favorable	Not needed	Droughty, percs slowly, slope.	Percs slowly	Slope, percs slowly, droughty.
Kenoma	Favorable	Hard to pack	Not needed	Erodes easily, percs slowly.	Erodes easily, percs slowly.	Percs slowly, erodes easily.
Ob*. Orthents						
Oc Osage	Favorable	Wetness, hard to pack.	Floods, percs slowly.	Wetness, slow intake, percs slowly.	Not needed	Percs slowly, wetness.
Ra Reading	Favorable	Favorable	Not needed	Favorable	Not needed	Erodes easily.
Ta, Tb Tully	Favorable	Hard to pack	Not needed	Percs slowly, erodes easily.	Percs slowly	Erodes easily, percs slowly.
Tc*:						
Tully	Favorable	Hard to pack	Not needed	Percs slowly, erodes easily, slope.	Percs slowly	Slope, erodes easily, percs slowly.
Clime	Slope, depth to rock.	Thin layer, hard to pack.	Not needed	Slow intake, percs slowly, rooting depth.	Depth to rock, percs slowly.	Slope, depth to rock, percs slowly.
Va Vinland	Depth to rock	Thin layer	Not needed	Rooting depth, slope.	Depth to rock	Rooting depth.
Za Zaar	Favorable	Hard to pack, wetness.	Percs slowly	Slow intake, wetness, percs slowly.	Wetness, percs slowly.	Percs slowly, wetness.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--RECREATIONAL DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Ba, Bb: Bates	Slight	Slight	Moderate: slope, depth to rock.	Slight.
Bc*:				
Bates	Slight	Slight	Moderate: slope, depth to rock.	Slight.
Collinsville	Moderate: slope.	Moderate: slope.	Severe: depth to rock, slope.	Slight.
Ca: Chase	Severe: floods.	Moderate: too clayey, wetness.	Moderate: too clayey, wetness, floods.	Moderate: too clayey.
Cb, Cc: Clime	Moderate: too clayey.	Moderate: too clayey.	Severe: too clayey.	Moderate: too clayey.
Cd*:				
Clime	Moderate: slope, too clayey.	Moderate: slope, too clayey.	Severe: slope, too clayey.	Moderate: too clayey.
Sogn	Severe: depth to rock.	Slight	Severe: depth to rock.	Slight.
Ea, Eb: Elmont	Moderate: percs slowly.	Slight	Moderate: slope, percs slowly.	Slight.
Ec: Elmont	Moderate: percs slowly.	Moderate: too clayey.	Moderate: slope, percs slowly.	Moderate: too clayey.
Ed: Eram	Moderate: percs slowly, wetness.	Slight	Moderate: slope, percs slowly, wetness.	Slight.
Ee: Eram	Moderate: percs slowly, too clayey, wetness.	Moderate: too clayey.	Moderate: slope, percs slowly, wetness.	Moderate: too clayey.
Ef*:				
Eram	Moderate: percs slowly, wetness.	Slight	Severe: slope.	Slight.
Bates	Slight	Slight	Severe: slope.	Slight.
Fa*:				
Florence	Severe: small stones.	Severe: small stones.	Severe: large stones, slope.	Severe: large stones, small stones.
Labette	Slight	Slight	Moderate: depth to rock, slope.	Moderate: too clayey.

See footnote at end of table.

TABLE 12.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Ia, Ib: Ivan	Severe: floods.	Moderate: floods.	Severe: floods.	Moderate: floods.
Ka: Kenoma	Severe: percs slowly.	Slight	Severe: percs slowly.	Slight.
Kb: Kenoma	Severe: percs slowly.	Moderate: too clayey.	Severe: percs slowly.	Moderate: too clayey.
Kc: Kenoma	Severe: percs slowly.	Slight	Severe: percs slowly.	Slight.
Kd: Kenoma	Severe: percs slowly.	Moderate: too clayey.	Severe: percs slowly.	Moderate: too clayey.
La, Lb, Lc: Labette	Slight	Slight	Moderate: depth to rock, slope.	Moderate: too clayey.
Ld*:				
Labette	Slight	Slight	Moderate: depth to rock.	Moderate: too clayey.
Dwight	Moderate: percs slowly.	Slight	Moderate: percs slowly.	Slight.
Le: Ladysmith	Moderate: percs slowly.	Slight	Moderate: too clayey, percs slowly.	Slight.
Ma, Mb, Mc: Martin	Moderate: too clayey, percs slowly.	Moderate: too clayey.	Moderate: too clayey, percs slowly, slope.	Moderate: too clayey.
Oa*:				
Olpe	Moderate: percs slowly, small stones.	Moderate: small stones.	Severe: slope.	Moderate: small stones.
Kenoma	Severe: percs slowly.	Slight	Severe: percs slowly.	Slight.
Ob*. Orthents				
Oc: Osage	Severe: floods, wetness, percs slowly.	Severe: wetness, too clayey.	Severe: too clayey, wetness, floods.	Severe: wetness, too clayey.
Ra: Reading	Severe: floods.	Slight	Moderate: percs slowly.	Slight.
Ta, Tb: Tully	Slight	Slight	Moderate: slope, too clayey.	Slight.
Tc*:				
Tully	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
Clime	Moderate: slope, too clayey.	Moderate: slope, too clayey.	Severe: slope, too clayey.	Moderate: too clayey.

See footnote at end of table.

TABLE 12.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Va------- Vinland	Slight-------	Slight-------	Severe: depth to rock, slope.	Slight.
Za------- Zaar	Severe: percs slowly, too clayey.	Severe: too clayey.	Severe: too clayey, wetness.	Severe: too clayey.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 13.--WILDLIFE HABITAT POTENTIALS

[See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Shrubs	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Woodland wildlife	Rangeland wildlife
Ba, Bb: Bates	Good	Good	Good	Fair	Fair	Good	Poor	Very poor.	Good	Fair	Good.
Bc*:											
Bates	Good	Good	Good	Fair	Fair	Good	Poor	Very poor.	Good	Fair	Good.
Collinsville	Poor	Poor	Fair	Poor	Poor	Fair	Very poor.	Very poor.	Poor	Poor	Fair.
Ca: Chase	Good	Good	Good	Good	Good	Good	Good	Fair	Good	Good	Good.
Cb, Cc: Clime	Fair	Fair	Fair	Poor	Poor	Fair	Very poor.	Very poor.	Fair	Poor	Fair.
Cd*:											
Clime	Fair	Fair	Fair	Poor	Poor	Fair	Very poor.	Very poor.	Fair	Poor	Fair.
Sogn	Very poor.	Very poor.	Poor	Very poor.	Very poor.	Poor	Very poor.	Very poor.	Very poor	Very poor	Poor.
Ea: Elmont	Good	Good	Fair	Fair	Fair	Good	Poor	Very poor.	Good	Fair	Fair.
Eb, Ec: Elmont	Fair	Good	Fair	Fair	Fair	Good	Poor	Very poor.	Fair	Fair	Fair.
Ed: Eram	Good	Good	Good	Fair	Fair	Good	Poor	Very poor.	Good	Fair	Good.
Ee: Eram	Good	Good	Fair	Fair	Fair	Good	Poor	Very poor.	Good	Fair	Fair.
Ef*:											
Eram	Fair	Good	Good	Fair	Fair	Good	Poor	Very poor.	Good	Fair	Good.
Bates	Good	Good	Good	Fair	Fair	Good	Poor	Very poor.	Good	Fair	Good.
Fa*:											
Florence	Poor	Good	Fair	Poor	Poor	Fair	Poor	Very poor.	Fair	Fair	Fair.
Labette	Fair	Good	Fair	Fair	Fair	Fair	Poor	Poor	Fair	Fair	Fair.
Ia, Ib: Ivan	Good	Good	Good	Good	Good	Good	Poor	Fair	Good	Good	Good.
Ka, Kb, Kc, Kd: Kenoma	Good	Good	Fair	Fair	Fair	Fair	Poor	Fair	Good	Fair	Fair.
La, Lb, Lc: Labette	Fair	Good	Fair	Fair	Fair	Fair	Poor	Poor	Fair	Fair	Fair.
Ld*:											
Labette	Fair	Good	Fair	Fair	Fair	Fair	Poor	Poor	Fair	Fair	Fair.
Dwight	Fair	Fair	Fair	Very poor.	Very poor.	Poor	Poor	Fair	Fair	Poor	Poor.

See footnote at end of table.

TABLE 13.--WILDLIFE HABITAT POTENTIALS--Continued

Soil name and map symbol	Potential for habitat elements								Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Rangeland wildlife
Le------------------ Ladysmith	Fair	Good	Fair	Fair	Fair	Good	Poor	Fair	Good	Fair	Good.
Ma------------------ Martin	Good	Good	Fair	Fair	Gooa	Good	Poor	Poor	Good	Fair	Good.
Mb, Mc-------------- Martin	Fair	Good	Fair	Fair	Good	Good	Poor	Very poor.	Good	Fair	Good.
Oa*:											
Olpe----------------	Fair	Good	Fair	Fair	Fair	Fair	Poor	Very poor.	Good	Fair	Fair.
Kenoma--------------	Good	Good	Fair	Fair	Fair	Fair	Poor	Poor	Good	Fair	Fair.
Ob*. Orthents											
Oc------------------ Osage	Fair	Fair	Fair	Fair	Fair	Fair	Poor	Good	Fair	Fair	Fair.
Ra------------------ Reading	Good	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Good.
Ta------------------ Tully	Good	Good	Fair	Fair	Fair	Fair	Poor	Poor	Good	Fair	Fair.
Tb------------------ Tully	Fair	Good	Fair	Fair	Fair	Fair	Poor	Poor	Fair	Fair	Fair.
Tc*:											
Tully---------------	Fair	Good	Fair	Fair	Fair	Fair	Poor	Poor	Fair	Fair	Fair.
Clime---------------	Fair	Fair	Fair	Poor	Poor	Fair	Very poor.	Very poor.	Fair	Poor	Fair.
Va------------------ Vinland	Poor	Poor	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Poor	Fair	Fair.
Za------------------ Zaar	Fair	Fair	Fair	Fair	Fair	Good	Poor	Very poor.	Fair	Fair	Fair.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--ENGINEERING PROPERTIES AND CLASSIFICATIONS

[The symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated]

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
Ba, Bb------------- Bates	0-17	Loam------------	ML, CL, CL-ML	A-4, A-6	0	90-100	85-100	80-100	55-90	20-40	3-15
	17-34	Loam, clay loam, sandy clay loam.	ML, CL	A-4, A-6	0	85-100	85-100	80-100	50-85	25-40	3-15
	34	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Bc*:											
Bates-------------	0-17	Loam------------	ML, CL, CL-ML	A-4, A-6	0	90-100	85-100	80-100	55-90	20-40	3-15
	17-31	Loam, clay loam, sandy clay loam.	ML, CL	A-4, A-6	0	85-100	85-100	80-100	50-85	25-40	3-15
	31	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Collinsville------	0-7	Fine sandy loam	SM, SC, ML, CL	A-4	0-3	80-100	60-100	60-95	36-75	<-30	NP-10
	7-11	Fine sandy loam, loam, gravelly fine sandy loam.	SM, SC, ML, CL	A-4	3-40	80-100	60-100	60-95	36-75	<-30	NP-10
	11	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Ca---------------- Chase	0-17	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	90-100	35-45	15-25
	17-60	Silty clay, silty clay loam, clay.	CH, CL	A-7-6	0	100	100	95-100	90-100	40-60	20-35
Cb, Cc------------- Clime	0-8	Silty clay------	CL, CH	A-7, A-6	0-20	90-100	90-100	85-100	80-95	38-60	18-30
	8-19	Silty clay, clay, silty clay loam.	CH, CL	A-7, A-6	0	100	100	95-100	85-95	38-60	18-35
	19-34	Silty clay, clay	CL, CH	A-7, A-6	0	85-100	80-100	75-95	60-90	30-55	11-30
	34	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Cd*:											
Clime-------------	0-8	Silty clay------	CL, CH	A-7, A-6	0-20	90-100	90-100	85-100	80-95	38-60	18-30
	8-19	Silty clay, clay, silty clay loam.	CH, CL	A-7, A-6	0	100	100	95-100	85-95	38-60	18-35
	19-34	Silty clay, clay	CL, CH	A-7, A-6	0	85-100	80-100	75-95	60-90	30-55	11-30
	34	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Sogn--------------	0-9	Silty clay loam	CL	A-6, A-7	0-10	85-100	85-100	85-100	80-95	25-45	11-23
	9	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Ea, Eb------------- Elmont	0-12	Silt loam-------	CL, CL-ML	A-4, A-6	0	100	100	90-100	75-100	25-40	5-15
	12-32	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	85-100	30-45	11-25
	32-48	Silty clay loam, clay loam, silty clay.	CL	A-6, A-7	0	100	100	95-100	85-100	30-50	15-30
	48-60	Unweathered bedrock.	---	---	---	---	---	---	---	---	---

See footnote at end of table.

TABLE 14.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

Soil name and map symbol	Depth	USDA texture	Classification Unified	Classification AASHTO	Fragments > 3 inches	Percentage passing sieve number-- 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
Ec-----------------Elmont	0-6	Silty clay loam	CL, CL-ML	A-4, A-6	0	100	100	90-100	75-100	25-40	5-15
	6-12	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	85-100	30-45	11-25
	12-41	Silty clay loam, clay loam, silty clay.	CL	A-6, A-7	0	100	100	95-100	85-100	30-50	15-30
	41-60	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Ed-----------------Eram	0-9	Silt loam--------	CL, ML	A-4, A-6	0	85-100	85-100	85-100	75-95	30-37	8-13
	9-34	Clay, silty clay, clay loam.	CL, CH	A-7, A-6	0	95-100	95-100	90-100	85-98	37-65	13-34
	34	Weathered bedrock.	---	---	---	---	---	---	---	---	---
Ee-----------------Eram	0-6	Silty clay loam	CL	A-6, A-7	0	85-100	85-100	85-100	75-95	33-48	12-22
	6-25	Clay, silty clay, clay loam.	CL, CH	A-7, A-6	0	95-100	95-100	90-100	85-98	37-65	13-34
	25	Weathered bedrock.	---	---	---	---	---	---	---	---	---
Ef*:											
Eram---------------	0-7	Silt loam--------	CL, ML	A-4, A-6	0	85-100	85-100	85-100	75-95	30-37	8-13
	7-27	Clay, silty clay, clay loam.	CL, CH	A-7, A-6	0	95-100	95-100	90-100	85-98	37-65	13-34
	27	Weathered bedrock.	---	---	---	---	---	---	---	---	---
Bates--------------	0-7	Loam-------------	ML, CL, CL-ML	A-4, A-6	0	100	100	90-100	55-90	20-40	3-15
	7-31	Loam, clay loam, sandy clay loam.	ML, CL	A-4, A-6	0	90-100	90-100	80-100	50-85	25-40	3-15
	31	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Fa*:											
Florence-----------	0-13	Cherty silt loam	GC, SC, CL	A-6, A-2-6	10-40	30-90	25-90	20-85	20-85	25-35	11-20
	13-18	Cherty silt loam, cherty silty clay loam.	GC	A-6, A-2-6	10-60	30-65	25-60	20-55	15-50	25-35	11-20
	18-46	Cherty silty clay, cherty clay, cherty silty clay loam.	GC, SC, CH	A-2-7, A-7	10-85	30-70	20-65	20-60	15-55	51-65	30-40
	46	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Labette------------	0-10	Silty clay loam	CL	A-6, A-7	0	85-100	85-100	85-95	85-95	30-50	11-22
	10-38	Silty clay, silty clay loam, cherty silty clay.	CH, CL	A-7-6	0-40	60-100	60-100	60-95	60-95	40-60	20-35
	38	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Ia, Ib-------------Ivan	0-35	Silt loam--------	CL	A-4, A-6, A-7	0	95-100	95-100	90-100	75-100	30-45	8-20
	35-60	Silt loam, silty clay loam, loam.	CL	A-4, A-6, A-7	0	95-100	95-100	90-100	65-100	30-45	8-20

See footnote at end of table.

TABLE 14.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
Ka------------------ Kenoma	0-10	Silt loam--------	CL, CL-ML	A-4, A-6	0	85-100	85-100	85-100	85-100	25-40	5-20
	10-40	Silty clay, clay	CH	A-7	0	85-100	85-100	85-100	85-100	50-65	30-45
	40-60	Silty clay, silty clay loam.	CL, CH	A-7	0	85-100	85-100	75-100	75-95	45-60	25-40
Kb------------------ Kenoma	0-6	Silty clay loam	CL, CL-ML	A-4, A-6	0	85-100	85-100	85-100	85-100	25-40	5-20
	6-38	Silty clay, clay	CH	A-7	0	85-100	85-100	85-100	85-100	50-65	30-45
	38-60	Silty clay, silty clay loam.	CL, CH	A-7	0	85-100	85-100	75-100	75-95	45-60	25-40
Kc------------------ Kenoma	0-10	Silt loam--------	CL, CL-ML	A-4, A-6	0	85-100	85-100	85-100	85-100	25-40	5-20
	10-40	Silty clay, clay	CH	A-7	0	85-100	85-100	85-100	85-100	50-65	30-45
	40-60	Silty clay, silty clay loam.	CL, CH	A-7	0	85-100	85-100	75-100	75-95	45-60	25-40
Kd------------------ Kenoma	0-6	Silty clay loam	CL, CL-ML	A-4, A-6	0	85-100	85-100	85-100	85-100	25-40	5-20
	6-38	Silty clay, clay	CH	A-7	0	85-100	85-100	85-100	85-100	50-65	30-45
	38-60	Silty clay, silty clay loam.	CL, CH	A-7	0	85-100	85-100	75-100	75-95	45-60	25-40
La, Lb, Lc---------- Labette	0-8	Silty clay loam	CL	A-6, A-7	0	85-100	85-100	85-95	85-95	30-50	11-22
	8-38	Silty clay, silty clay loam, cherty silty clay.	CH, CL	A-7-6	0-40	60-100	60-100	60-95	60-95	40-60	20-35
	38	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Ld*: Labette------------	0-8	Silty clay loam	CL	A-6, A-7	0	85-100	85-100	85-95	85-95	30-50	11-22
	8-38	Silty clay, silty clay loam, cherty silty clay.	CH, CL	A-7-6	0-40	60-100	60-100	60-95	60-95	40-60	20-35
	38	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Dwight-------------	0-4	Silt loam--------	CL-ML, CL	A-4, A-6	0	100	100	95-100	85-100	25-40	5-15
	4-20	Clay, silty clay	CH	A-7-6	0	100	100	95-100	90-100	50-65	25-40
	20-49	Clay, silty clay, silty clay loam.	CL, CH	A-7-6	0	100	100	95-100	90-100	45-60	25-40
	49	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Le------------------ Ladysmith	0-8	Silty clay loam	CL	A-6	0	100	100	95-100	90-100	30-40	10-20
	8-37	Silty clay, clay	CH	A-7-6	0	100	100	95-100	90-100	50-65	30-45
	37-60	Silty clay, silty clay loam, clay.	CL, CH	A-7-6	0	100	100	95-100	90-100	40-55	15-30
Ma, Mb------------- Martin	0-12	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	80-99	35-50	15-25
	12-60	Silty clay, clay	CH, CL	A-7	0	100	100	95-100	80-98	41-70	25-40
Mc------------------ Martin	0-18	Silty clay-------	CL	A-6, A-7	0	100	100	95-100	80-99	35-50	15-25
	18-60	Silty clay, clay	CH, CL	A-7	0	100	100	95-100	80-98	41-70	25-40

See footnote at end of table.

TABLE 14.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
Oa*:											
Olpe	0-15	Gravelly silt loam.	GC	A-2, A-4, A-6	0	30-65	25-60	20-55	15-50	20-30	7-15
	15-25	Gravelly silty clay loam, gravelly silty clay.	GC	A-2, A-6, A-7	0	30-65	25-60	20-55	15-50	25-45	11-22
	25-60	Gravelly silty clay, gravelly clay, gravelly silty clay loam.	GC	A-2-7, A-7	0	30-65	25-60	20-55	15-50	40-60	25-40
Kenoma	0-10	Silt loam	CL, CL-ML	A-4, A-6	0	85-100	85-100	85-100	85-100	25-40	5-20
	10-38	Silty clay, clay	CH	A-7	0	85-100	85-100	85-100	85-100	50-65	30-45
	38-60	Silty clay, silty clay loam.	CL, CH	A-7	0	85-100	85-100	75-100	75-95	45-60	25-40
Ob*. Orthents											
Oc Osage	0-13	Silty clay	CH	A-7	0	100	100	100	95-100	50-75	30-55
	13-60	Silty clay, clay	CH	A-7	0	100	100	100	95-100	50-80	30-55
Ra Reading	0-17	Silt loam	CL, CL-ML	A-4, A-6	0	100	100	90-100	85-100	25-40	5-20
	17-45	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	90-100	35-50	15-30
	45-60	Silty clay loam, clay loam, silty clay.	CL	A-6, A-7	0	100	100	95-100	80-100	35-50	15-30
Ta, Tb Tully	0-17	Silty clay loam	CL	A-6, A-7	0	85-100	85-100	85-100	85-95	35-50	11-22
	17-60	Silty clay, clay, cherty silty clay.	CH, CL	A-7	0	85-100	85-100	85-100	85-95	40-60	20-35
Tc*:											
Tully	0-17	Silty clay loam	CL, ML	A-6, A-7	0	85-100	85-100	85-100	85-95	35-50	11-22
	17-60	Silty clay, clay, cherty silty clay.	CH, CL	A-7	0	85-100	85-100	85-100	85-95	40-60	20-35
Clime	0-8	Silty clay	CL, CH	A-7, A-6	0-20	90-100	90-100	85-100	80-95	38-60	18-30
	8-19	Silty clay, clay, silty clay loam.	CH, CL	A-7, A-6	0	100	100	95-100	85-95	38-60	18-35
	19-34	Silty clay, clay	CL, CH	A-7, A-6	0	85-100	80-100	75-95	60-90	30-55	11-30
	34-50	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Va Vinland	0-19	Loam	ML, SM, CL, SC	A-4	0	85-100	85-100	75-95	45-70	20-35	NP-10
	19	Weathered bedrock.	---	---	---	---	---	---	---	---	---
Za Zaar	0-14	Silty clay	CH	A-7	0	100	100	95-100	90-95	50-70	25-40
	14-60	Silty clay, clay, silty clay loam.	CH	A-7	0	100	100	95-100	90-95	50-70	25-40

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS

[The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated]

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	In/hr	In/in	pH				
Ba, Bb: Bates	0-17	0.6-2.0	0.20-0.22	5.1-6.5	Low	0.28	4	6
	17-34	0.6-2.0	0.15-0.19	5.1-6.5	Low	0.28		
	34	---	---	---	---	---		
Bc*: Bates	0-17	0.6-2.0	0.20-0.22	5.1-6.5	Low	0.28	4	6
	17-31	0.6-2.0	0.15-0.19	5.1-6.5	Low	0.28		
	31	---	---	---	---	---		
Collinsville	0-7	2.0-6.0	0.12-0.16	5.1-6.5	Low	0.20	2	3
	7-11	2.0-6.0	0.09-0.13	5.1-6.5	Low	0.20		
	11	---	---	---	---	---		
Ca: Chase	0-17	0.2-0.6	0.21-0.24	5.6-7.3	Moderate	0.37	5	7
	17-60	0.06-0.2	0.11-0.19	5.6-7.8	High	0.37		
Cb, Cc: Clime	0-8	0.06-0.6	0.12-0.20	7.4-8.4	Moderate	0.28	3	4
	8-19	0.06-0.6	0.12-0.18	7.9-8.4	Moderate	0.28		
	19-34	0.06-0.6	0.11-0.15	7.9-8.4	Moderate	0.28		
	34	---	---	---	---	---		
Cd*: Clime	0-8	0.06-0.6	0.12-0.20	7.4-8.4	Moderate	0.28	3	4
	8-19	0.06-0.6	0.12-0.18	7.9-8.4	Moderate	0.28		
	19-34	0.06-0.6	0.11-0.15	7.9-8.4	Moderate	0.28		
	34	---	---	---	---	---		
Sogn	0-9	0.6-2.0	0.17-0.22	6.1-8.4	Moderate	0.32	1	4L
	9	---	---	---	---	---		
Ea, Eb: Elmont	0-12	0.6-2.0	0.19-0.24	5.6-7.3	Low	0.32	5	6
	12-32	0.2-0.6	0.18-0.20	5.6-7.3	Moderate	0.43		
	32-48	0.2-0.6	0.14-0.20	5.6-7.3	Moderate	0.43		
	48-60	---	---	---	---	---		
Ec: Elmont	0-6	0.6-2.0	0.19-0.24	5.6-7.3	Low	0.32	5	6
	6-12	0.2-0.6	0.18-0.20	5.6-7.3	Moderate	0.43		
	12-41	0.2-0.6	0.14-0.20	5.6-7.3	Moderate	0.43		
	41-60	---	---	---	---	---		
Ed: Eram	0-9	0.2-2.0	0.16-0.24	5.6-6.5	Low	0.37	3	6
	9-34	0.06-0.2	0.14-0.18	5.1-7.3	High	0.37		
	34	---	---	---	---	---		
Ee: Eram	0-6	0.2-0.6	0.15-0.19	5.6-6.5	Moderate	0.37	3	7
	6-25	0.06-0.2	0.14-0.18	5.1-7.3	High	0.37		
	25	---	---	---	---	---		
Ef*: Eram	0-7	0.2-2.0	0.16-0.24	5.6-6.5	Low	0.37	3	6
	7-27	0.06-0.2	0.14-0.18	5.1-7.3	High	0.37		
	27	---	---	---	---	---		
Bates	0-7	0.6-2.0	0.20-0.22	5.1-6.5	Low	0.28	4	6
	7-31	0.6-2.0	0.15-0.19	5.1-6.5	Low	0.28		
	31	---	---	---	---	---		
Fa*: Florence	0-13	0.6-2.0	0.08-0.15	5.6-7.3	Low	0.24	3	8
	13-18	0.6-2.0	0.04-0.12	5.6-7.3	Low	0.24		
	18-46	0.2-0.6	0.04-0.10	5.6-7.3	Moderate	0.24		
	46	---	---	---	---	---		

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	In/hr	In/in	pH				
Fa*:								
Labette----------	0-10	0.2-0.6	0.21-0.24	5.6-6.5	Moderate------	0.37	3	7
	10-38	0.06-0.2	0.18-0.23	5.6-8.4	High----------	0.37		
	38	---	---	---	--------------	---		
Ia, Ib----------- Ivan	0-35	0.6-2.0	0.21-0.24	7.4-8.4	Moderate------	0.32	5	4L
	35-60	0.6-2.0	0.17-0.22	7.9-8.4	Moderate------	0.32		
Ka--------------- Kenoma	0-10	0.2-0.6	0.22-0.24	5.1-6.5	Low-----------	0.43	4	6
	10-40	<0.06	0.12-0.15	5.1-7.8	High----------	0.32		
	40-60	0.06-0.2	0.18-0.20	6.1-8.4	High----------	0.32		
Kb--------------- Kenoma	0-6	0.2-0.6	0.22-0.24	5.1-6.5	Low-----------	0.43	4	6
	6-38	<0.06	0.12-0.15	5.1-7.8	High----------	0.32		
	38-60	0.06-0.2	0.18-0.20	6.1-8.4	High----------	0.32		
Kc--------------- Kenoma	0-10	0.2-0.6	0.22-0.24	5.1-6.5	Low-----------	0.43	4	6
	10-40	<0.06	0.12-0.15	5.1-7.8	High----------	0.32		
	40-60	0.06-0.2	0.18-0.20	6.1-8.4	High----------	0.32		
Kd--------------- Kenoma	0-6	0.2-0.6	0.22-0.24	5.1-6.5	Low-----------	0.43	4	6
	6-38	<0.06	0.12-0.15	5.1-7.8	High----------	0.32		
	38-60	0.06-0.2	0.18-0.20	6.1-8.4	High----------	0.32		
La, Lb, Lc------- Labette	0-8	0.2-0.6	0.21-0.24	5.6-6.5	Moderate------	0.37	3	7
	8-38	0.06-0.2	0.18-0.23	5.6-8.4	High----------	0.37		
	38	---	---	---	--------------	---		
Ld*:								
Labette----------	0-8	0.2-0.6	0.21-0.24	5.6-6.5	Moderate------	0.37	3	7
	8-38	0.06-0.2	0.18-0.23	5.6-8.4	High----------	0.37		
	38	---	---	---	--------------	---		
Dwight-----------	0-4	0.6-2.0	0.21-0.24	5.6-7.3	Low-----------	0.43	3	6
	4-20	>0.06	0.10-0.15	6.1-8.4	High----------	0.32		
	20-49	0.06-0.6	0.10-0.15	6.6-8.4	High----------	0.32		
	49	---	---	---	--------------	---		
Le--------------- Ladysmith	0-8	0.2-2.0	0.21-0.23	5.6-7.3	Moderate------	0.37	4	7
	8-37	<0.06	0.10-0.15	5.6-7.8	High----------	0.37		
	37-60	0.06-0.6	0.10-0.19	7.4-8.4	Moderate------	0.37		
Ma, Mb, Mc------- Martin	0-12	0.2-0.6	0.21-0.23	5.6-6.5	Moderate------	0.37	4	7
	12-60	0.06-0.2	0.12-0.18	5.6-7.8	High----------	0.37		
Oa*:								
Olpe-------------	0-15	0.6-2.0	0.06-0.13	5.1-6.5	Low-----------	0.24	3	6
	15-25	0.2-0.6	0.04-0.10	5.1-6.5	Low-----------	0.24		
	25-60	<0.2	0.04-0.10	5.6-7.8	Moderate------	0.24		
Kenoma-----------	0-10	0.2-0.6	0.22-0.24	5.1-6.5	Low-----------	0.43	4	6
	10-38	<0.06	0.12-0.15	5.1-7.8	High----------	0.32		
	38-60	0.06-0.2	0.18-0.20	6.1-8.4	High----------	0.32		
Ob*. Orthents								
Oc--------------- Osage	0-13	<0.06	0.12-0.14	5.1-7.3	High----------	0.28	5	4
	13-60	<0.06	0.08-0.12	5.6-7.8	High----------	0.28		
Ra--------------- Reading	0-17	0.6-2.0	0.21-0.23	5.6-7.3	Low-----------	0.32	5	6
	17-45	0.2-2.0	0.18-0.20	5.6-7.3	Moderate------	0.43		
	45-60	0.2-2.0	0.13-0.20	6.1-8.4	Moderate------	0.43		
Ta, Tb----------- Tully	0-17	0.2-2.0	0.18-0.23	5.6-7.3	Moderate------	0.37	4	7
	17-60	0.06-0.2	0.10-0.15	6.1-8.4	High----------	0.37		

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS--Continued

Soil name and map symbol	Depth	Permea- bility	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group
						K	T	
	In	In/hr	In/in	pH				
Tc*:								
Tully-----------	0-17	0.2-2.0	0.18-0.23	5.6-7.3	Moderate------	0.37	4	7
	17-60	0.06-0.2	0.10-0.15	6.1-8.4	High----------	0.37		
Clime-----------	0-8	0.06-0.6	0.12-0.20	7.4-8.4	Moderate------	0.28	3	4
	8-19	0.06-0.6	0.12-0.18	7.9-8.4	Moderate------	0.28		
	19-34	0.06-0.6	0.11-0.15	7.9-8.4	Moderate------	0.28		
	34-50	---	---	---	--------------	---		
Va--------------- Vinland	0-19	0.6-2.0	0.17-0.21	5.6-7.8	Low-----------	0.32	2	7
	19	---	---	---	--------------	---		
Za--------------- Zaar	0-14	<0.06	0.12-0.18	5.6-6.5	High----------	0.28	5	4
	14-60	<0.06	0.12-0.18	6.6-8.4	High----------	0.28		

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 16.--SOIL AND WATER FEATURES

[The definitions of "flooding" and "water table" in the Glossary explain terms such as "rare," "brief," and "perched." The symbol > means more than. Absence of an entry indicates that the feature is not a concern]

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Bedrock		Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hard-ness	Uncoated steel	Concrete
					Ft			In			
Ba, Bb----------- Bates	B	None--------	---	---	>6.0	---	---	20-40	Rip-pable	Low------	Moderate.
Bc*:											
Bates------------	B	None--------	---	---	>6.0	---	---	20-40	Rip-pable	Low------	Moderate.
Collinsville-----	C	None--------	---	---	>6.0	---	---	4-20	Hard	Low------	Moderate.
Ca--------------- Chase	C	Occasional--	Very brief	Mar-Sep	1.0-3.0	Perched	Feb-May	>60	---	High-----	Low.
Cb, Cc----------- Clime	C	None--------	---	---	>6.0	---	---	20-40	Rip-pable	High-----	Low.
Cd*:											
Clime------------	C	None--------	---	---	>6.0	---	---	20-40	Rip-pable	High-----	Low.
Sogn-------------	D	None--------	---	---	>6.0	---	---	4-20	Hard	Low------	Low.
Ea, Eb, Ec-------- Elmont	B	None--------	---	---	>6.0	---	---	40-80	Rip-pable	Moderate	Low.
Ed, Ee----------- Eram	C	None--------	---	---	2.0-3.0	Perched	Dec-Apr	20-40	Rip-pable	High-----	Moderate.
Ef*:											
Eram-------------	C	None--------	---	---	2.0-3.0	Perched	Dec-Apr	20-40	Rip-pable	High-----	Moderate.
Bates------------	B	None--------	---	---	>6.0	---	---	20-40	Rip-pable	Low------	Moderate.
Fa*:											
Florence---------	C	None--------	---	---	>6.0	---	---	40-60	Hard	Moderate	Low.
Labette----------	C	None--------	---	---	>6.0	---	---	20-40	Hard	High-----	Low.
Ia, Ib----------- Ivan	B	Frequent----	Very brief	Dec-Jun	>6.0	---	---	>60	---	Low------	Low.
Ka, Kb, Kc, Kd---- Kenoma	D	None--------	---	---	>6.0	---	---	>60	---	High-----	Moderate.
La, Lb, Lc-------- Labette	C	None--------	---	---	>6.0	---	---	20-40	Hard	High-----	Low.
Ld*:											
Labette----------	C	None--------	---	---	>6.0	---	---	20-40	Hard	High-----	Low.
Dwight-----------	D	None--------	---	---	>6.0	---	---	>40	Hard	High-----	Moderate.
Le--------------- Ladysmith	D	None--------	---	---	>6.0	---	---	>60	---	High-----	Low.
Ma, Mb, Mc-------- Martin	C	None--------	---	---	>6.0	---	---	>60	---	High-----	Low.
Oa*:											
Olpe-------------	C	None--------	---	---	>6.0	---	---	>60	---	High-----	Moderate.
Kenoma-----------	D	None--------	---	---	>6.0	---	---	>60	---	High-----	Moderate.
Ob*. Orthents											

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock		Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness	Uncoated steel	Concrete
					Ft			In			
Oc: Osage	D	Frequent	Brief to long.	Nov-May	0-1.0	Perched	Nov-May	>60	---	High	Moderate.
Ra: Reading	C	Rare	---	---	>6.0	---	---	>60	---	Moderate	Low.
Ta, Tb: Tully	C	None	---	---	>6.0	---	---	>60	---	High	Low.
Tc*:											
Tully	C	None	---	---	>6.0	---	---	>60	---	High	Low.
Clime	C	None	---	---	>6.0	---	---	20-40	Rippable	High	Low.
Va: Vinland	D	None	---	---	>6.0	---	---	10-20	Rippable	Moderate	Low.
Za: Zaar	D	None	---	---	1.0-2.0	Perched	Dec-Apr	>60	---	High	Moderate.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 17.--CLASSIFICATION OF THE SOILS

Soil name	Family or higher taxonomic class
Bates	Fine-loamy, siliceous, thermic Typic Argiudolls
Chase	Fine, montmorillonitic, mesic Aquic Argiudolls
Clime	Fine, mixed, mesic Udic Haplustolls
Collinsville	Loamy, siliceous, thermic Lithic Hapludolls
Dwight	Fine, montmorillonitic, mesic Typic Natrustolls
Elmont	Fine-silty, mixed, mesic Typic Argiudolls
Eram	Fine, mixed, thermic Aquic Argiudolls
Florence	Clayey-skeletal, montmorillonitic, mesic Udic Argiustolls
Ivan	Fine-silty, mixed, mesic Cumulic Hapludolls
Kenoma	Fine, montmorillonitic, thermic Vertic Argiudolls
Labette	Fine, mixed, mesic Udic Argiustolls
Ladysmith	Fine, montmorillonitic, mesic Pachic Argiustolls
Martin	Fine, montmorillonitic, mesic Aquic Argiudolls
Olpe	Clayey-skeletal, montmorillonitic, thermic Typic Paleudolls
Orthents	Fine, mixed, mesic Udorthents
Osage	Fine, montmorillonitic, thermic Vertic Haplaquolls
Reading	Fine-silty, mixed, mesic Typic Argiudolls
Sogn	Loamy, mixed, mesic Lithic Haplustolls
Tully	Fine, mixed, mesic Pachic Argiustolls
Vinland	Loamy, mixed, mesic, shallow Typic Hapludolls
Zaar	Fine, montmorillonitic, thermic Vertic Hapludolls

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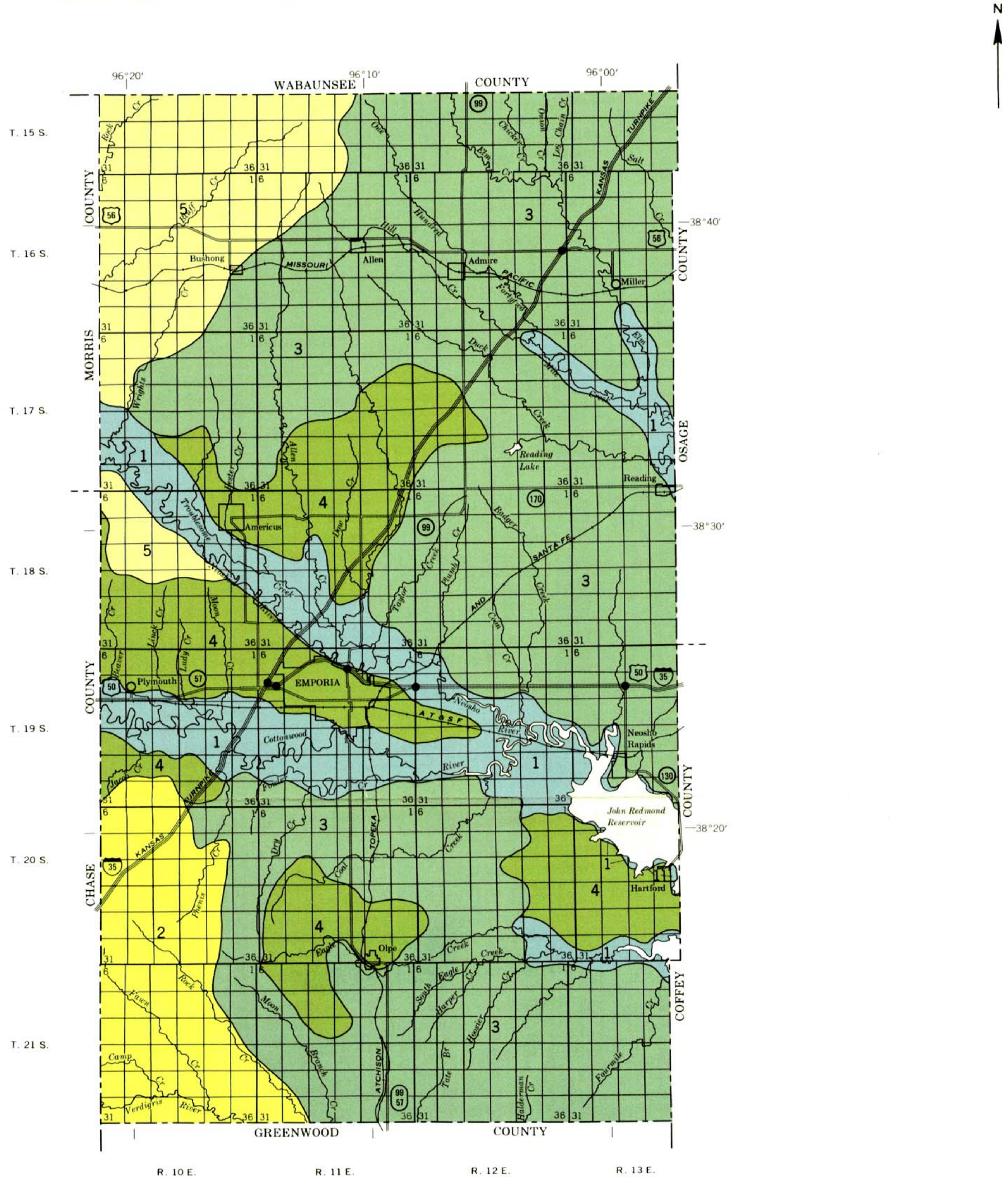


U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
KANSAS AGRICULTURAL EXPERIMENT STATION

GENERAL SOIL MAP
LYON COUNTY, KANSAS

Scale 1: 253,440

1 0 1 2 3 4 Miles

1 0 1 2 3 4 5 6 Kilometers

SOIL LEGEND

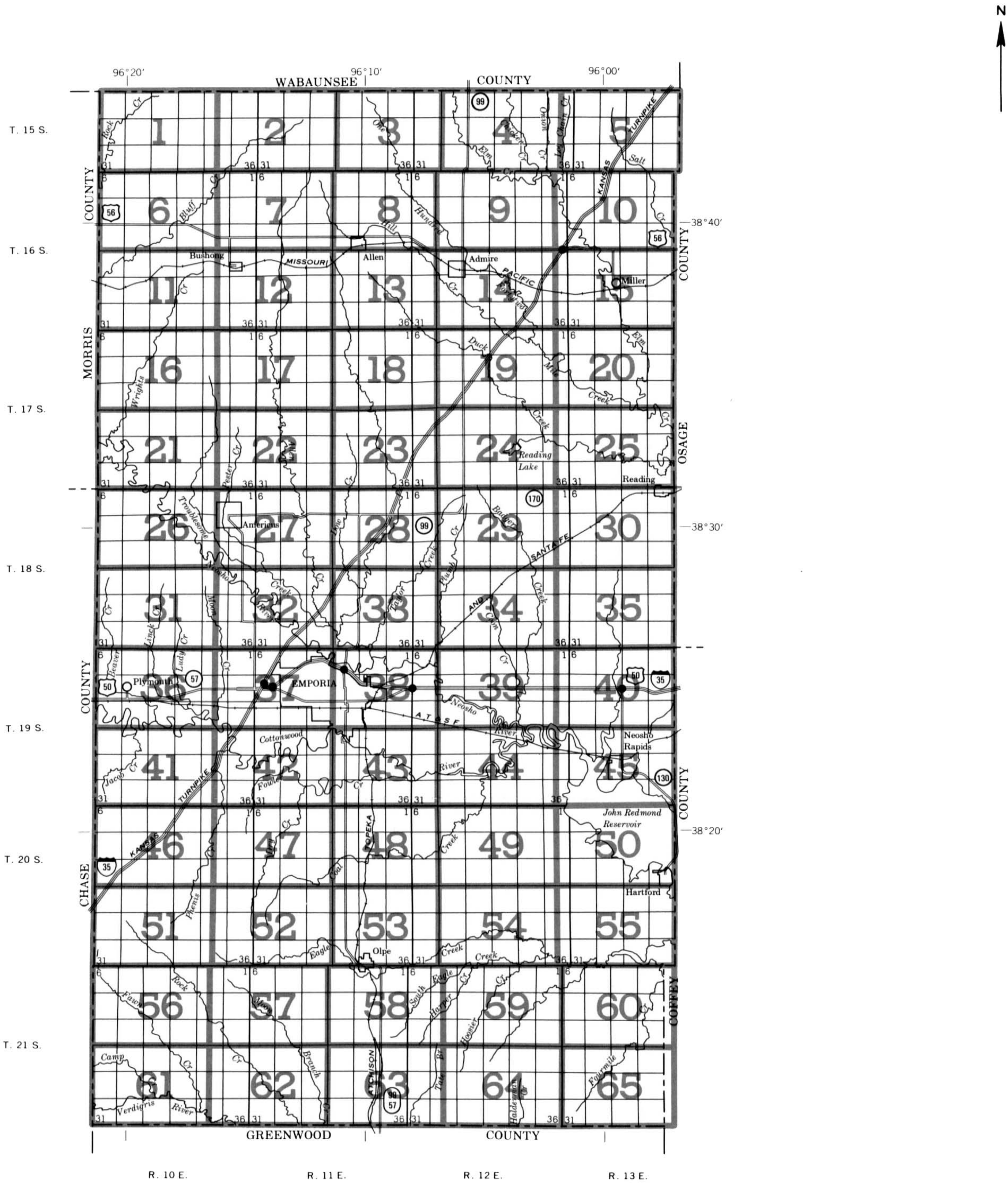
1	Chase-Osage association: Deep, nearly level, moderately well drained and poorly drained soils that have a dominantly silty clay subsoil; on flood plains and low terraces
2	Clime-Sogn association: Moderately deep and shallow, moderately sloping to moderately steep, moderately well drained and somewhat excessively drained soils that have a silty clay subsoil or lack a subsoil; on uplands
3	Kenoma-Martin-Elmont association: Deep, gently sloping and moderately sloping, moderately well drained and well drained soils that have a silty clay or silty clay loam subsoil; on uplands
4	Kenoma-Ladysmith association: Deep, nearly level and gently sloping, moderately well drained soils that have a silty clay subsoil; on uplands
5	Tully-Florence association: Deep, gently sloping and strongly sloping, well drained soils that have a dominantly silty clay or cherty clay subsoil; on uplands

Compiled 1980

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.



INDEX TO MAP SHEETS

LYON COUNTY, KANSAS

Scale 1:253,440

1 0 1 2 3 4 Miles

1 0 1 2 3 4 5 6 Kilometers

Original text from each individual map sheet read:

This map is compiled on 1978 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

CONVENTIONAL AND SPECIAL SYMBOLS LEGEND

CULTURAL FEATURES

BOUNDARIES

- National, state or province
- County or parish
- Minor civil division
- Reservation (national forest or park, state forest or park, and large airport)
- Land grant
- Limit of soil survey (label)
- Field sheet matchline & neatline

AD HOC BOUNDARY (label)

- Small airport, airfield, park, oilfield, cemetery, or flood pool (Davis Airstrip; FLOOD POOL LINE)

STATE COORDINATE TICK

LAND DIVISION CORNERS (sections and land grants)

ROADS

- Divided (median shown if scale permits)
- Other roads
- Trail

ROAD EMBLEMS & DESIGNATIONS

- Interstate (79)
- Federal (410)
- State (52)
- County, farm or ranch (378)

RAILROAD

POWER TRANSMISSION LINE (normally not shown)

PIPE LINE (normally not shown)

FENCE (normally not shown)

LEVEES

- Without road
- With road
- With railroad

DAMS

- Large (to scale)
- Medium or small (water; w)

PITS

- Gravel pit
- Mine or quarry

MISCELLANEOUS CULTURAL FEATURES

- Farmstead, house (omit in urban areas)
- Church
- School
- Indian mound (label) (Indian Mound)
- Located object (label) (Tower)
- Tank (label) (GAS)
- Wells, oil or gas
- Windmill
- Kitchen midden

WATER FEATURES

DRAINAGE

- Perennial, double line
- Perennial, single line
- Intermittent
- Drainage end
- Canals or ditches
  - Double-line (label) (CANAL)
  - Drainage and/or irrigation

LAKES, PONDS AND RESERVOIRS

- Perennial (water; w)
- Intermittent (int; i)

MISCELLANEOUS WATER FEATURES

- Marsh or swamp
- Spring
- Well, artesian
- Well, irrigation
- Wet spot

SPECIAL SYMBOLS FOR SOIL SURVEY

SOIL DELINEATIONS AND SYMBOLS (Bb Tc)

ESCARPMENTS

- Bedrock (points down slope)
- Other than bedrock (points down slope)

SHORT STEEP SLOPE

GULLY

DEPRESSION OR SINK

SOIL SAMPLE SITE (normally not shown)

MISCELLANEOUS

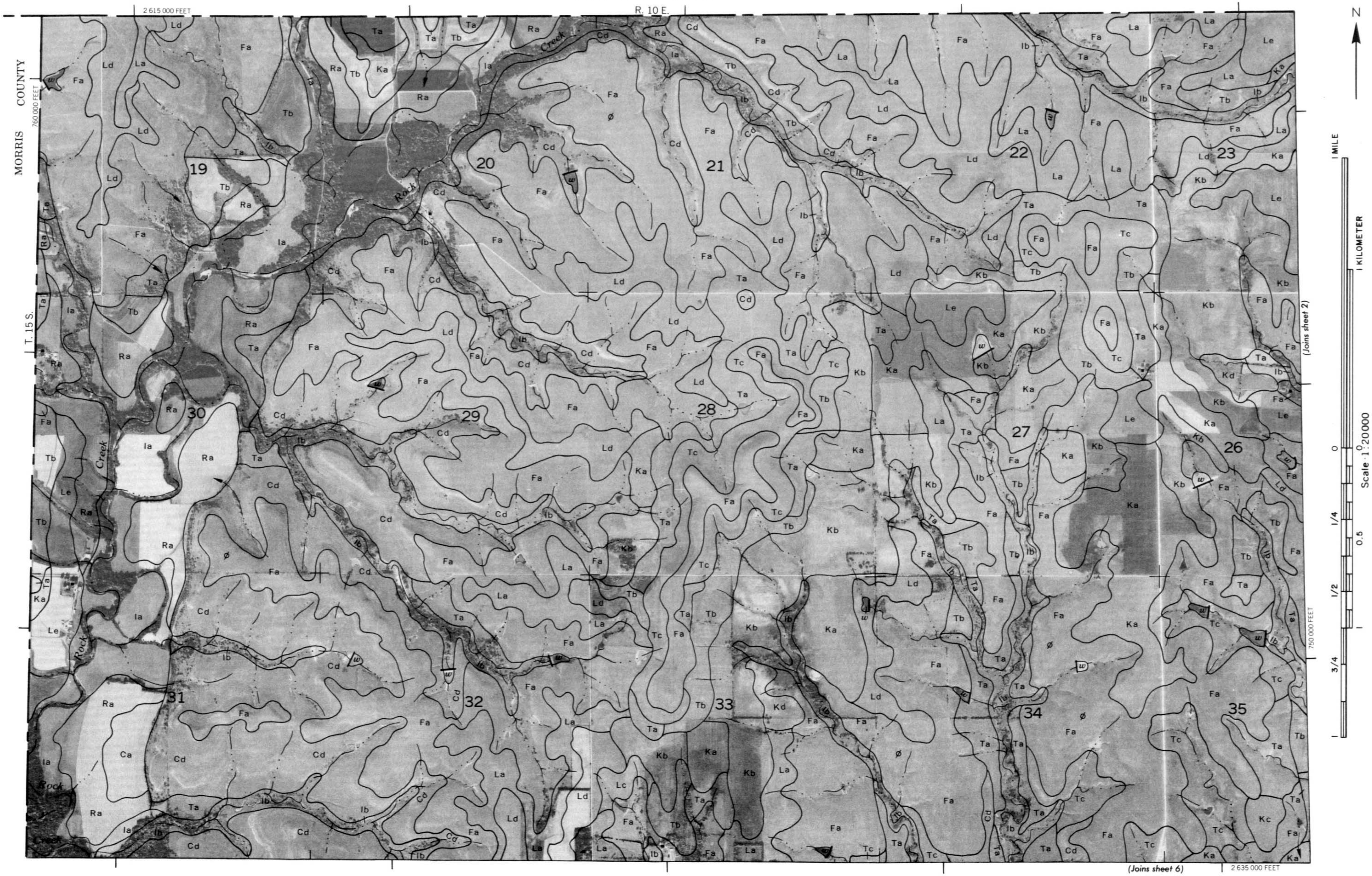
- Blowout
- Clay spot
- Gravelly spot
- Gumbo, slick or scabby spot (sodic)
- Dumps and other similar non soil areas
- Prominent hill or peak
- Rock outcrop (includes sandstone and shale)
- Saline spot
- Sandy spot
- Severely eroded spot
- Slide or slip (tips point upslope)
- Stony spot, very stony spot
- Oil field waste land

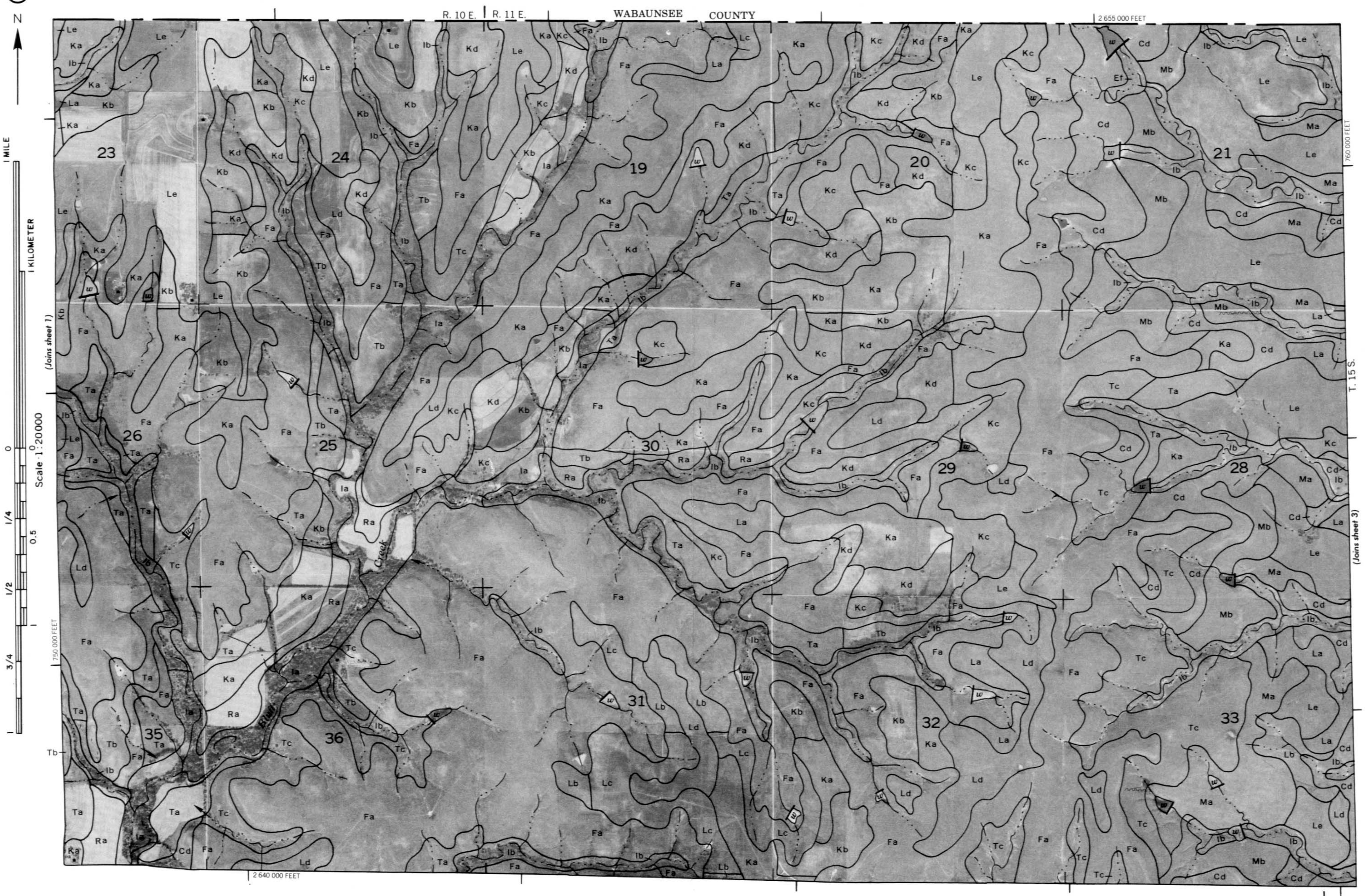
SOIL LEGEND

SYMBOL	NAME
Ba	Bates loam, 3 to 6 percent slopes
Bb	Bates loam, 3 to 6 percent slopes, eroded
Bc	Bates-Collinsville complex, 3 to 15 percent slopes
Ca	Chase silty clay loam
Cb	Clime silty clay, 3 to 7 percent slopes
Cc	Clime silty clay, 3 to 7 percent slopes, eroded
Cd	Clime-Sogn complex, 5 to 20 percent slopes
Ea	Elmont silt loam, 1 to 4 percent slopes
Eb	Elmont silt loam, 4 to 7 percent slopes
Ec	Elmont silty clay loam, 3 to 7 percent slopes, eroded
Ed	Eram silt loam, 3 to 6 percent slopes
Ee	Eram silty clay loam, 3 to 6 percent slopes, eroded
Ef	Eram and Bates soils, 6 to 15 percent slopes
Fa	Florence-Labette complex, 2 to 12 percent slopes
Ia	Ivan silt loam
Ib	Ivan silt loam, channeled
Ka	Kenoma silt loam, 1 to 3 percent slopes
Kb	Kenoma silty clay loam, 1 to 3 percent slopes, eroded
Kc	Kenoma silt loam, 3 to 6 percent slopes
Kd	Kenoma silty clay loam, 3 to 6 percent slopes, eroded
La	Labette silty clay loam, 1 to 3 percent slopes
Lb	Labette silty clay loam, 3 to 6 percent slopes
Lc	Labette silty clay loam, 2 to 6 percent slopes, eroded
Ld	Labette-Dwight complex, 0 to 2 percent slopes
Le	Ladysmith silty clay loam, 0 to 2 percent slopes
Ma	Martin silty clay loam, 1 to 4 percent slopes
Mb	Martin silty clay loam, 4 to 7 percent slopes
Mc	Martin silty clay, 3 to 7 percent slopes, eroded
Oa	Olpe-Kenoma complex, 3 to 15 percent slopes
Ob	Orthents, clayey
Oc	Osage silty clay
Ra	Reading silt loam
Ta	Tully silty clay loam, 2 to 7 percent slopes
Tb	Tully silty clay loam, 3 to 7 percent slopes, eroded
Tc	Tully-Clime complex, 7 to 15 percent slopes
Va	Vinland loam, 4 to 10 percent slopes
Za	Zaar silty clay, 2 to 5 percent slopes

LYON COUNTY, KANSAS — SHEET NUMBER 1

WABAUNSEE COUNTY





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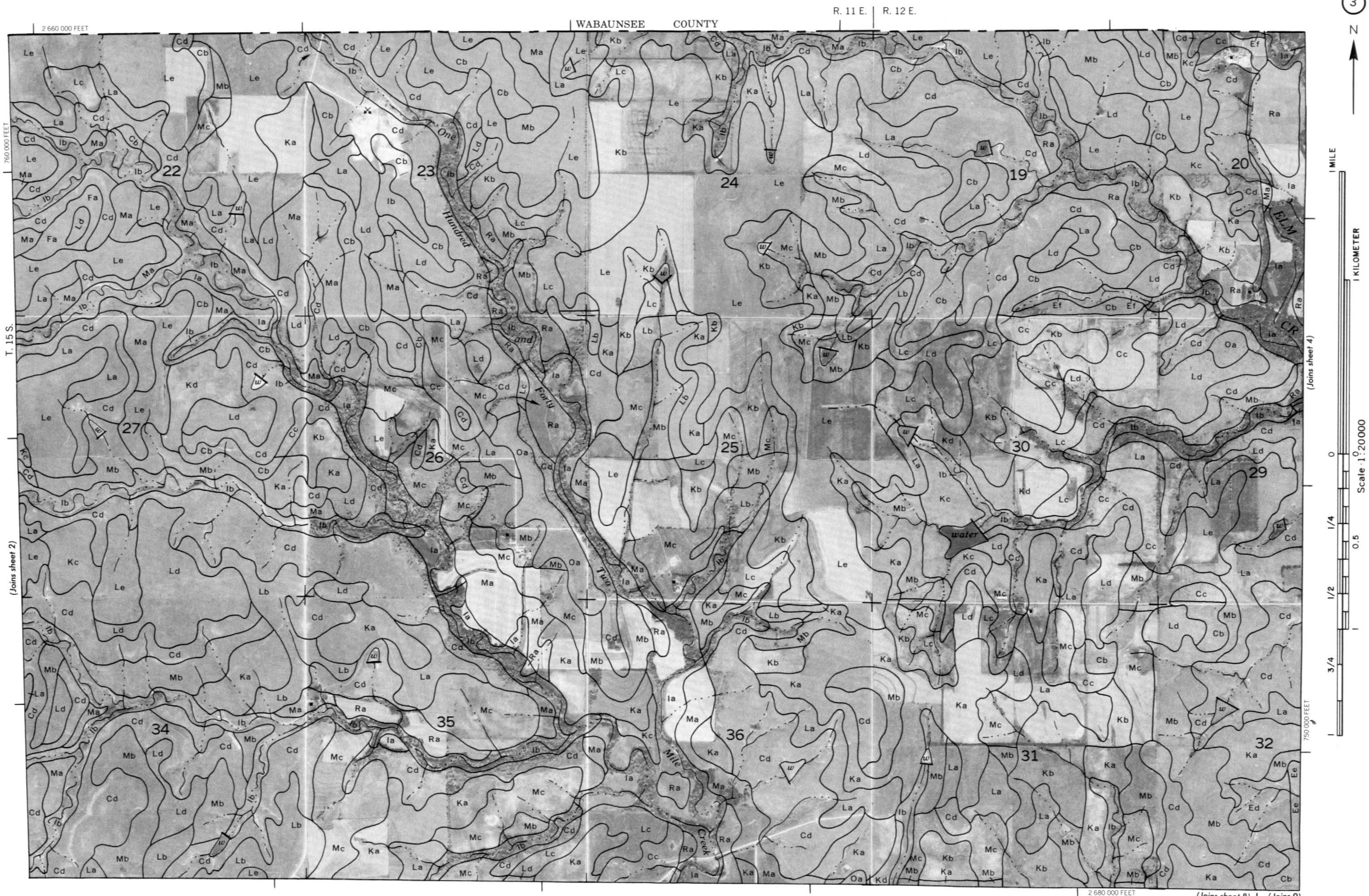
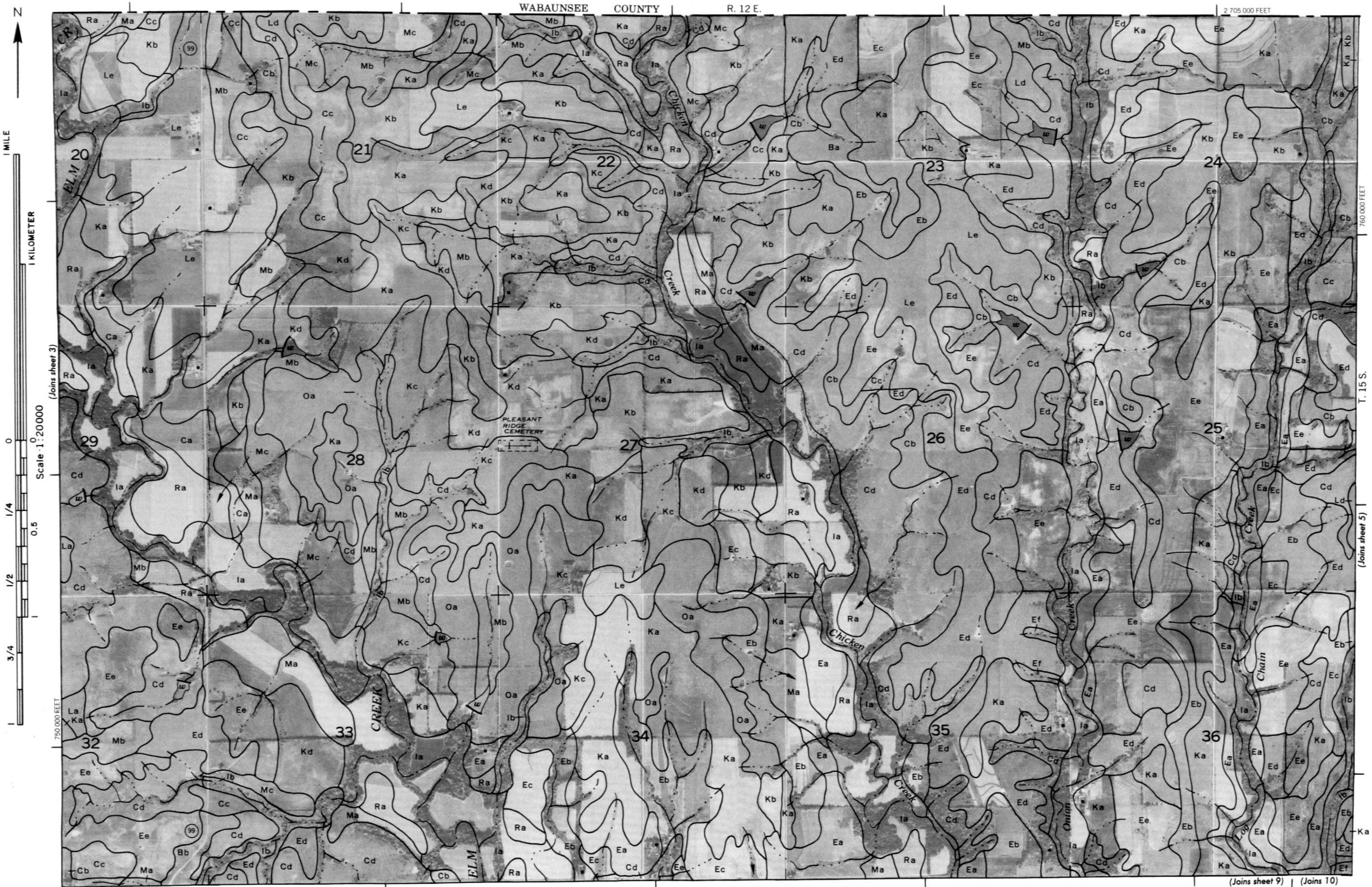
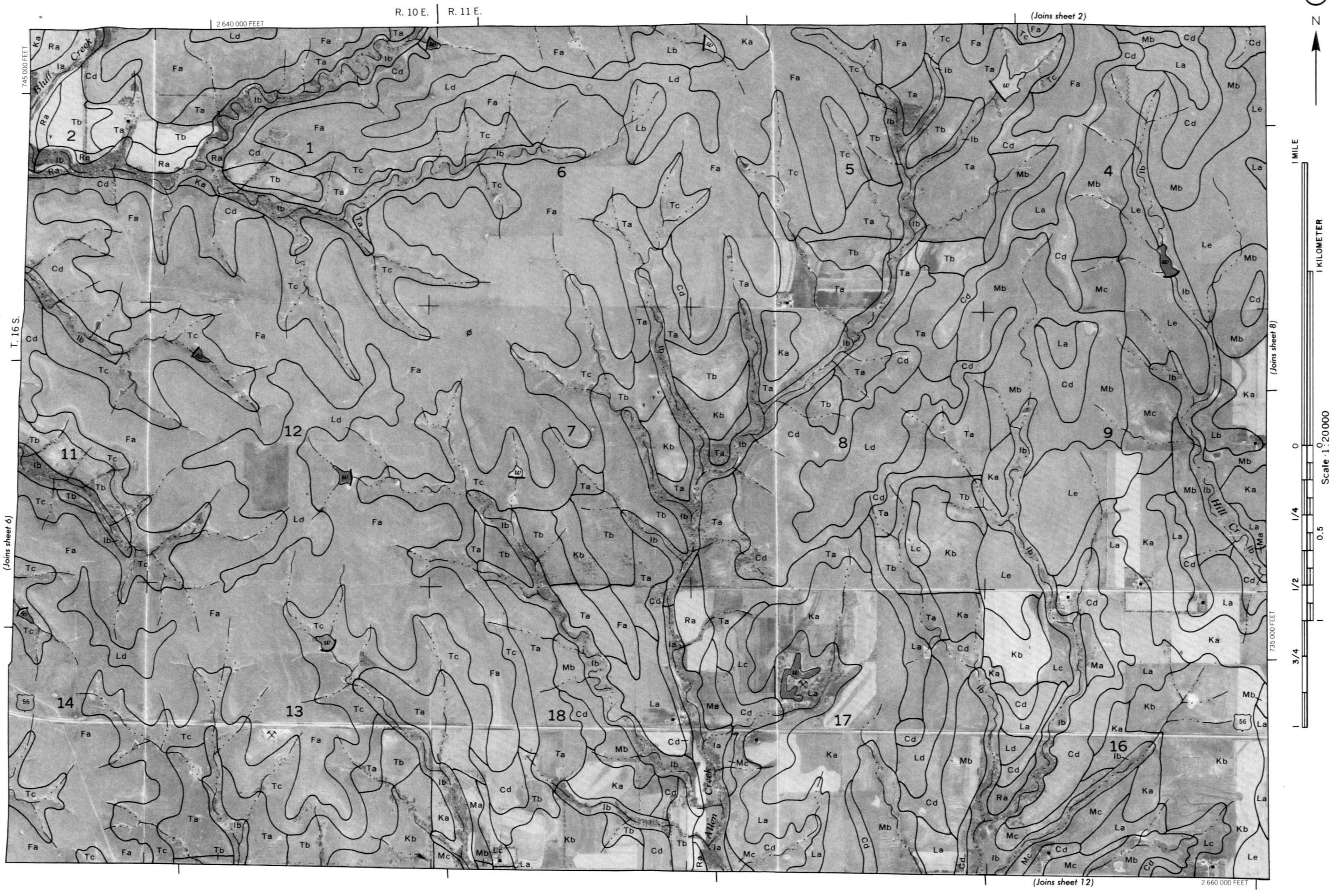


WABAUNSEE COUNTY
R. 11 E.
R. 12 E.
T. 15 S.
2 660 000 FEET
760 000 FEET
750 000 FEET
2 680 000 FEET
One Hundred and Forty Two Mile Creek
ELM CR
water
(Joins sheet 2)
(Joins sheet 4)
(Joins sheet 8)
(Joins 9)
N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5

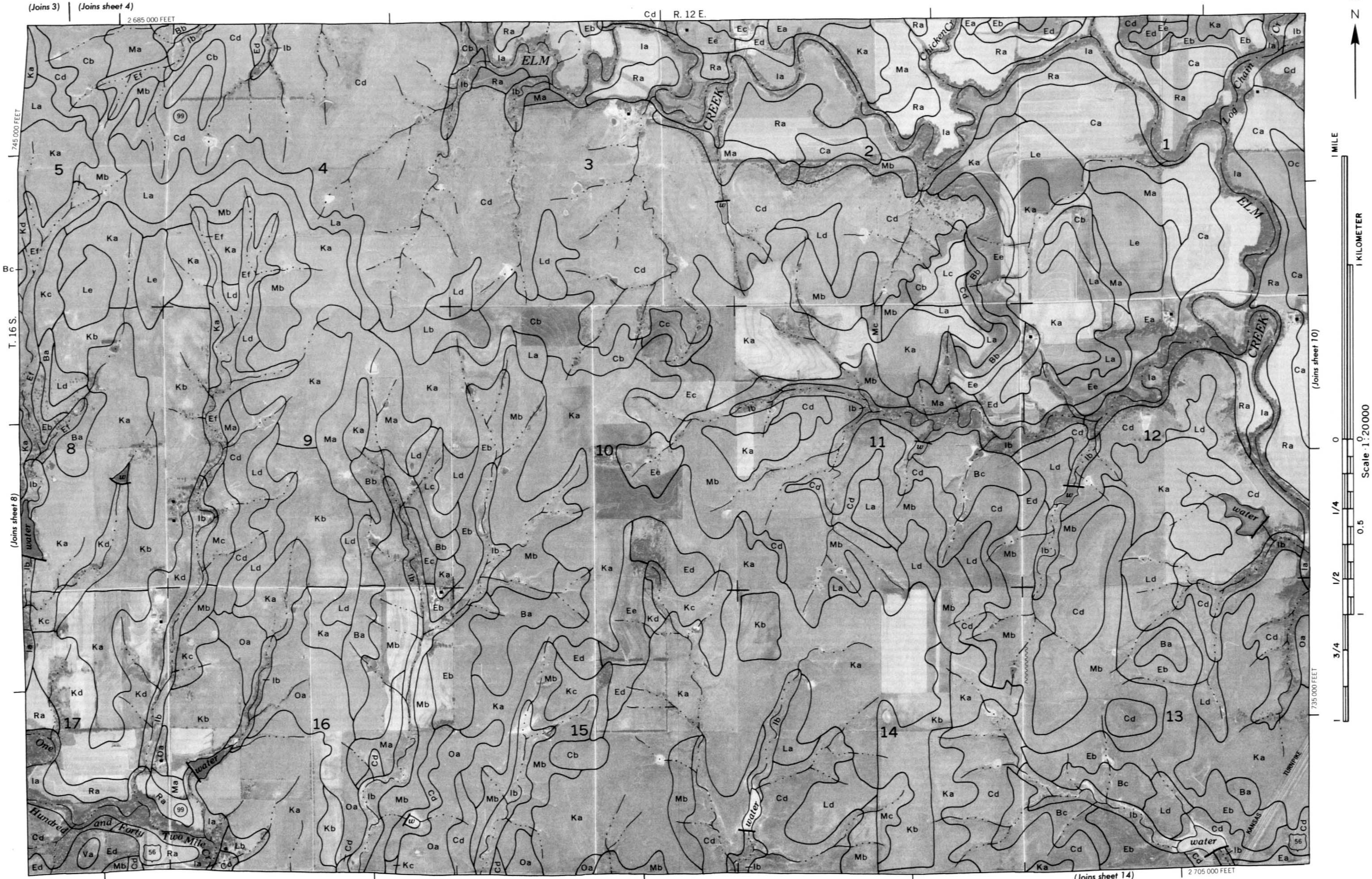

N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0
0.5
1
WABAUNSEE COUNTY
R. 12 E.
2 705 000 FEET
760 000 FEET
T. 15 S.
750 000 FEET
2 685 000 FEET
(Joins sheet 3)
(Joins sheet 5)
(Joins sheet 9)
(Joins 10)
PLEASANT RIDGE CEMETERY
ELM CR
Chicken Creek
Chicken Creek
Onion Creek
Log Chain Creek
ELM CREEK
20
21
22
23
24
25
26
27
28
29
32
33
34
35
36
99


5
N
WABAUNSEE COUNTY
OSAGE COUNTY
R. 13 E.
T. 15 S.
2 710 000 FEET
760 000 FEET
750 000 FEET
2 730 000 FEET
(Joins sheet 4)
(Joins sheet 10)
OS CO
TURNPIKE
KANSAS
19
20
21
22
27
28
29
30
31
32
33
34
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5

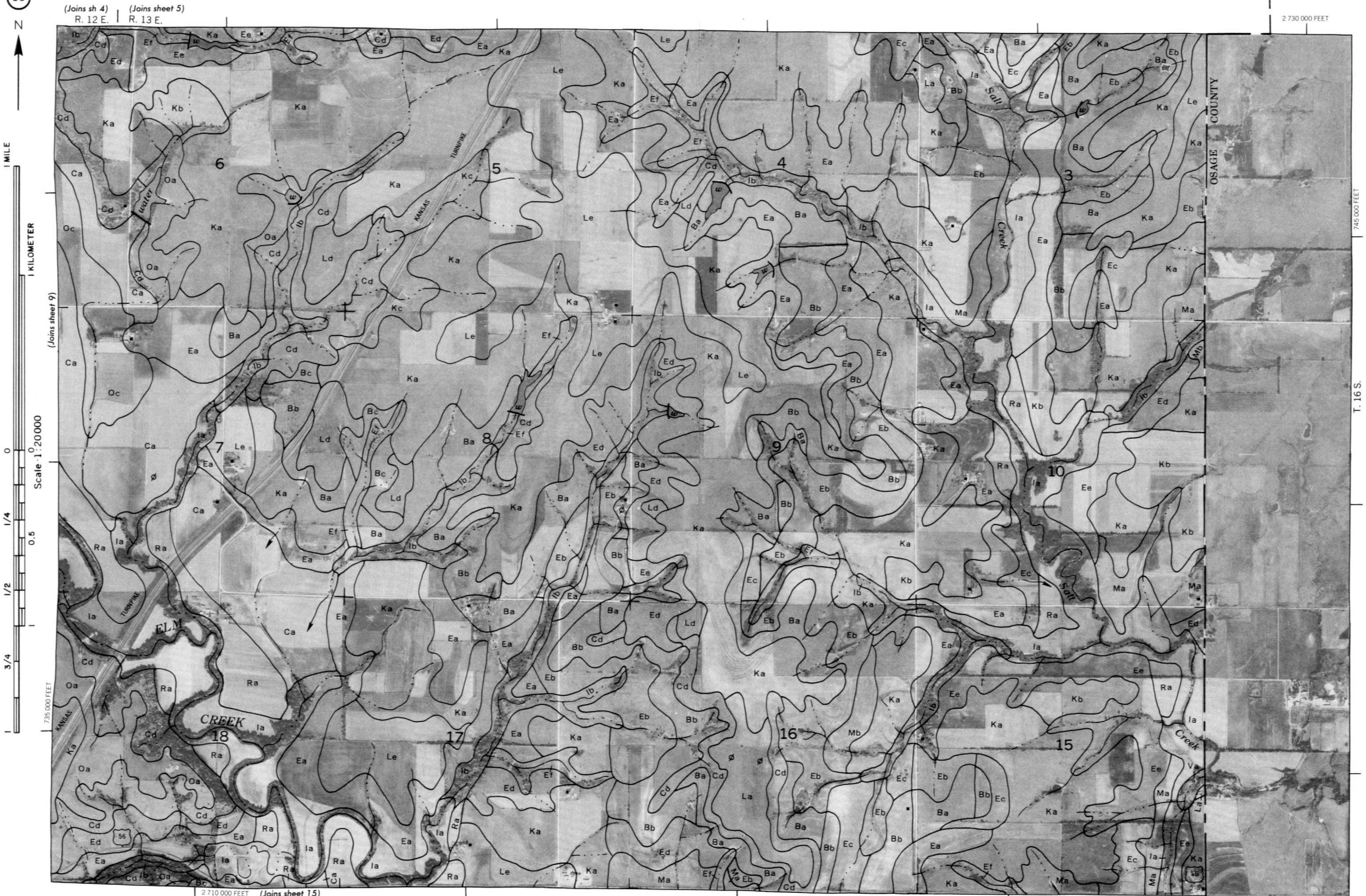

N
(Joins sheet 1)
R. 10 E.
2 635 000 FEET
745 000 FEET
T. 16 S.
(Joins sheet 7)
(Joins sheet 11)
2 615 000 FEET
735 000 FEET
MORRIS COUNTY
Scale 1:20000
1 MILE
1 KILOMETER
0
1/4
1/2
3/4
1
0.5
AGNES CITY CEMETERY
Rock Creek
Bluff Creek
water
56

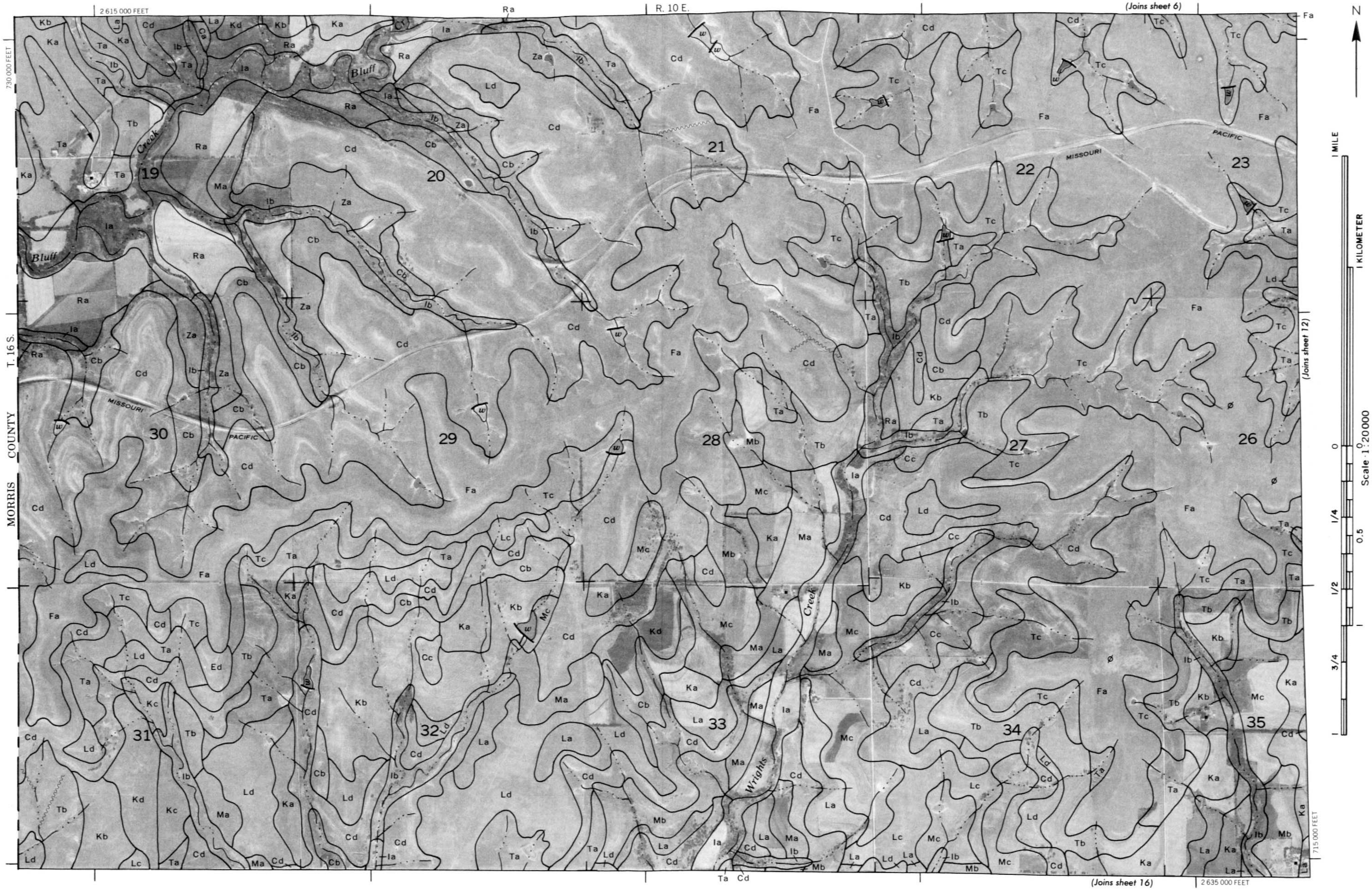

7
N
R. 10 E.
R. 11 E.
2 640 000 FEET
745 000 FEET
(Joins sheet 2)
T. 16 S.
(Joins sheet 6)
(Joins sheet 8)
735 000 FEET
(Joins sheet 12)
2 660 000 FEET
Bluff Creek
Allen Creek
Hill Cr.
56
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0
0.5
1


(sh 2)
(Joins sheet 3)
R. 11 E.
R. 12 E.
2 680 000 FEET
745 000 FEET
T. 16 S.
(Joins sheet 7)
(Joins sheet 9)
(Joins sheet 13)
2 665 000 FEET
735 000 FEET
N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
0.5
1/2
3/4
1
One Hundred and Forty Two Mile Creek
Hill Creek
Admire-Allen City Lake
Northern Heights High School
Allen
ALLEN CEMETERY
MISSOURI PACIFIC
water
56

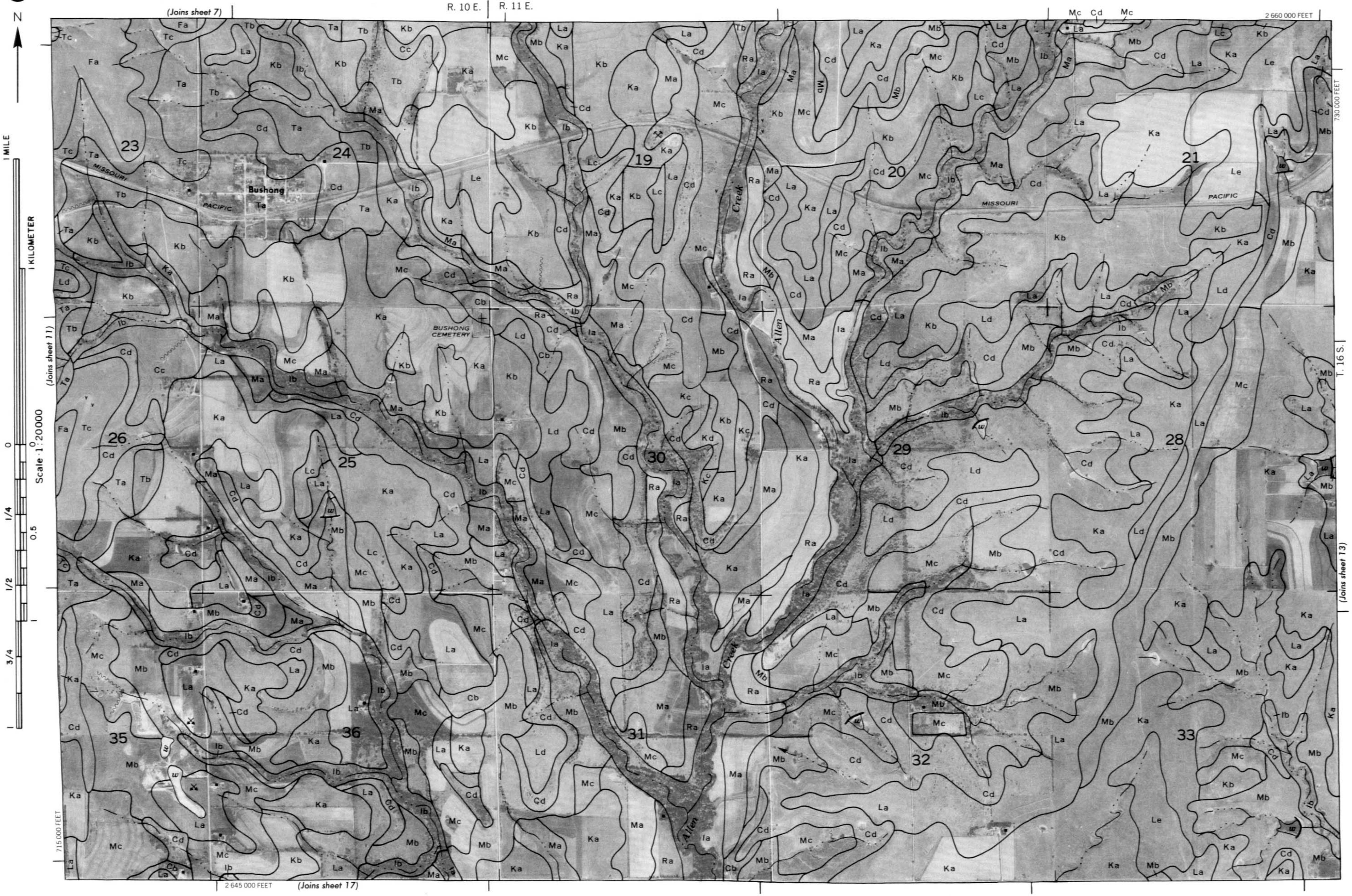

9
N
(Joins 3)
(Joins sheet 4)
2 685 000 FEET
R. 12 E.
745 000 FEET
T. 16 S.
(Joins sheet 8)
(Joins sheet 10)
(Joins sheet 14)
2 705 000 FEET
735 000 FEET
ELM
CREEK
Chicken Cr.
Log Chain Cr.
Hundred and Forty Two Mile Cr.
One
water
KANSAS TURNPIKE
99
56
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0.5

LYON COUNTY, KANSAS — SHEET NUMBER 10

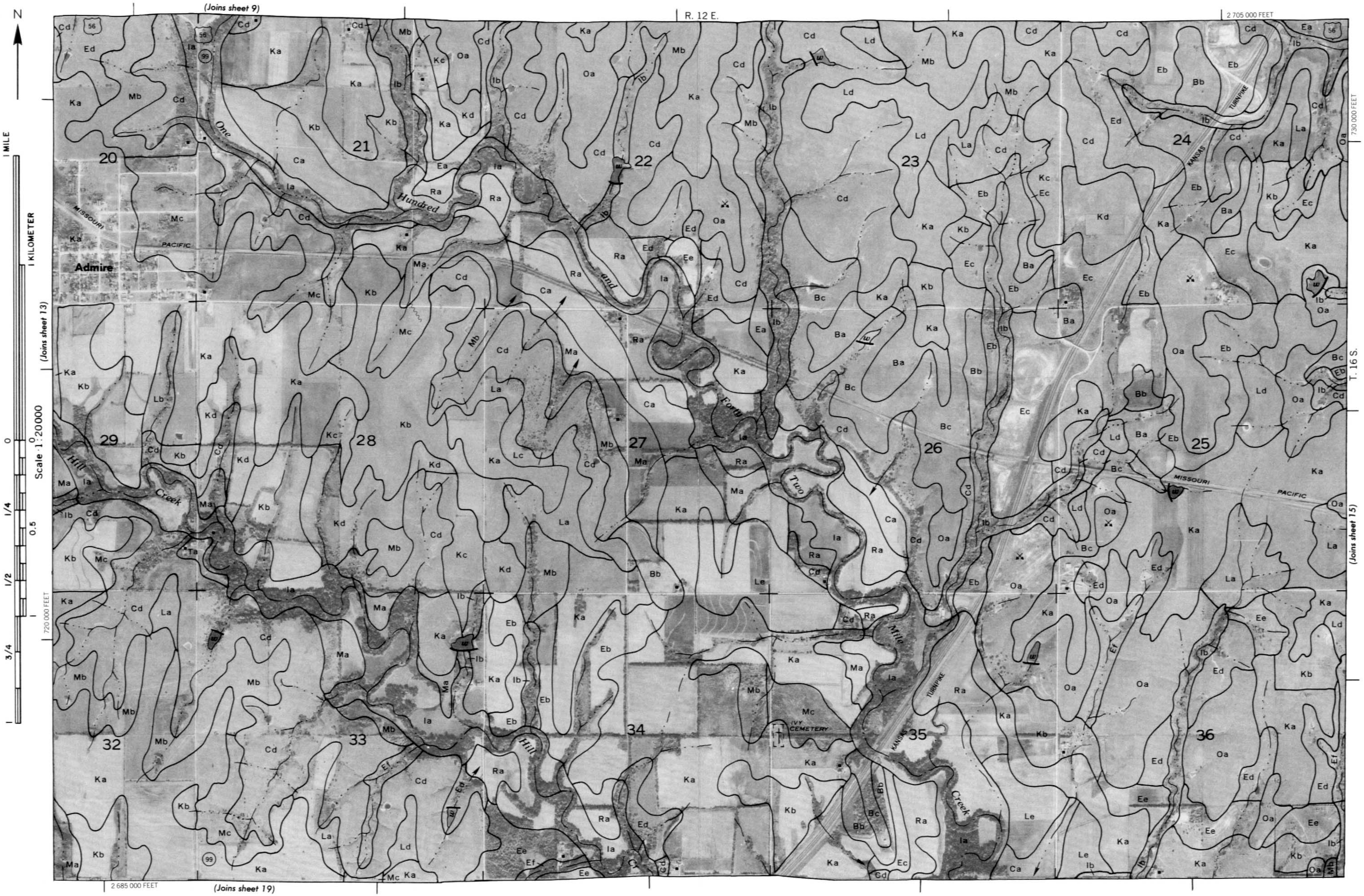



11
N
(Joins sheet 6)
(Joins sheet 12)
(Joins sheet 16)
2 615 000 FEET
2 635 000 FEET
730 000 FEET
715 000 FEET
R. 10 E.
T. 16 S.
MORRIS COUNTY
Bluff
Creek
Wrights
MISSOURI PACIFIC
19
20
21
22
23
26
27
28
29
30
31
32
33
34
35
1 MILE
1 KILOMETER
Scale 1:20000

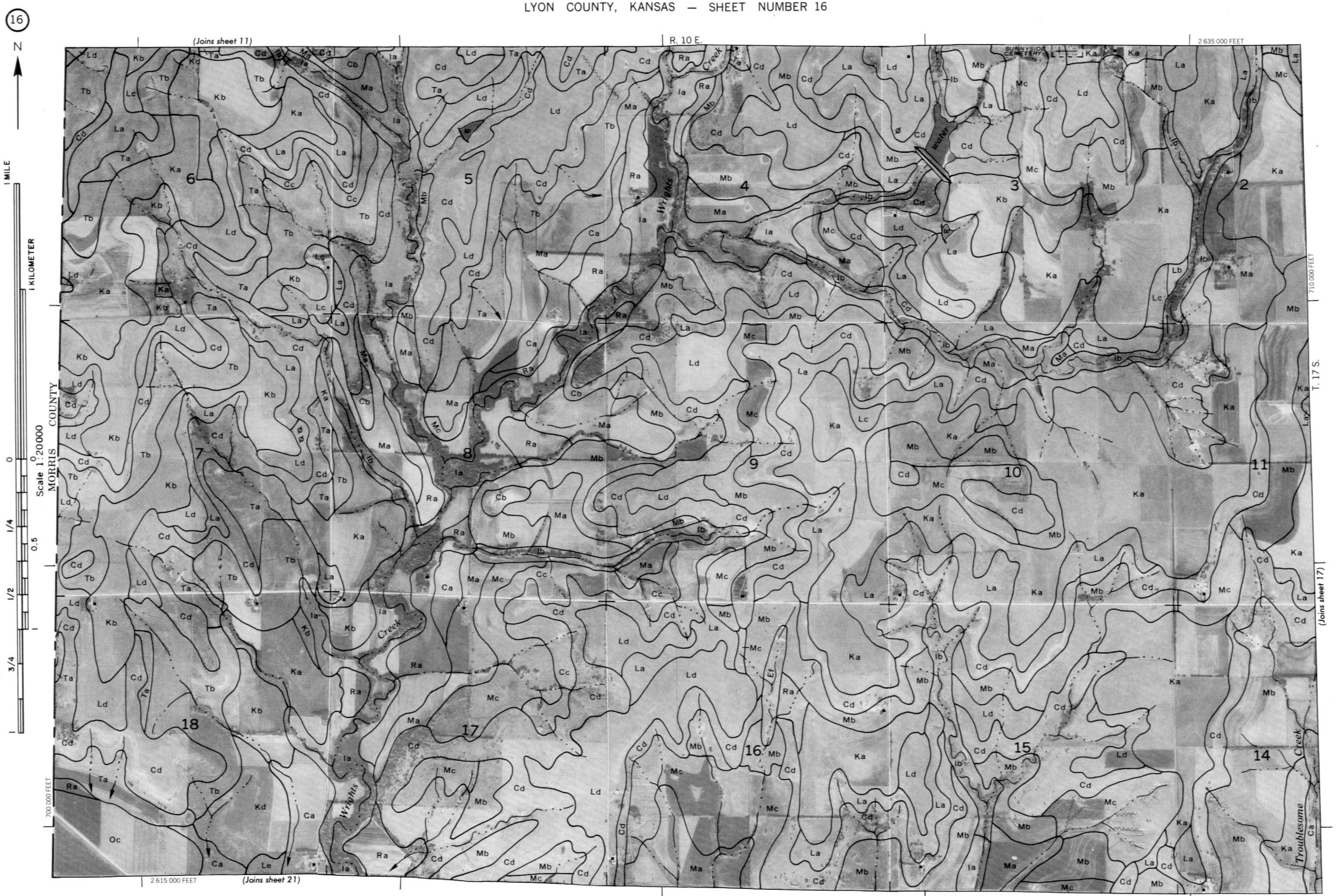
LYON COUNTY, KANSAS — SHEET NUMBER 12

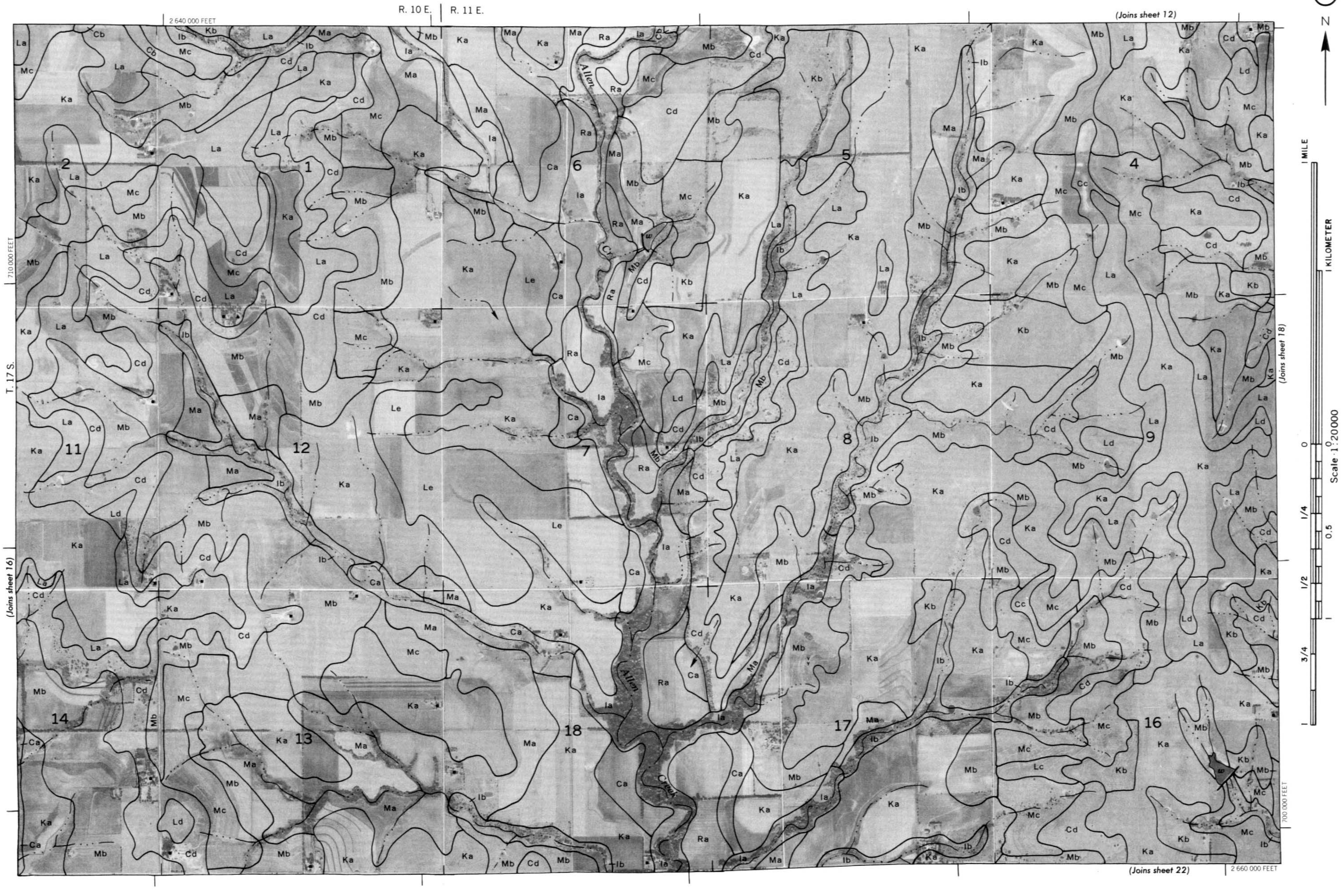



N
2 665 000 FEET
730 000 FEET
R. 11 E.
R. 12 E.
(Joins sheet 8)
ADMIRE CEMETERY
56
MISSOURI PACIFIC
T. 16 S.
(Joins sheet 12)
(Joins sheet 14)
(Joins sheet 18)
720 000 FEET
2 680 000 FEET
22
23
24
19
20
27
26
25
30
29
34
35
36
31
32
Hill Creek
Duck Creek
Dow Creek
water
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0
0.5
1


N
(Joins sheet 9)
R. 12 E.
2 705 000 FEET
730 000 FEET
T. 16 S.
(Joins sheet 15)
(Joins sheet 13)
(Joins sheet 19)
2 685 000 FEET
720 000 FEET
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0
0.5
1
Admire
MISSOURI PACIFIC
One Hundred and Forty Two Mile Creek
Hill Creek
KANSAS TURNPIKE
IVY CEMETERY
20
21
22
23
24
25
26
27
28
29
32
33
34
35
36


15
N
R. 13 E.
T. 16 S.
2 710 000 FEET
2 730 000 FEET
730 000 FEET
720 000 FEET
(Joins sheet 10)
(Joins sheet 14)
(Joins sheet 20)
ELM CREEK
MISSOURI PACIFIC
Miller
OSAGE COUNTY
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0
0.5
1
19
20
21
22
27
28
29
30
31
32
33
34


N
(Joins sheet 11)
R. 10 E.
SUNNYSIDE CEMETERY
2 635 000 FEET
710 000 FEET
T. 17 S.
(Joins sheet 17)
(Joins sheet 21)
2 615 000 FEET
700 000 FEET
MORRIS COUNTY
Scale 1:20000
1 MILE
1 KILOMETER
0
1/4
1/2
3/4
1
0.5
Wrights Creek
Troublesome Creek
water

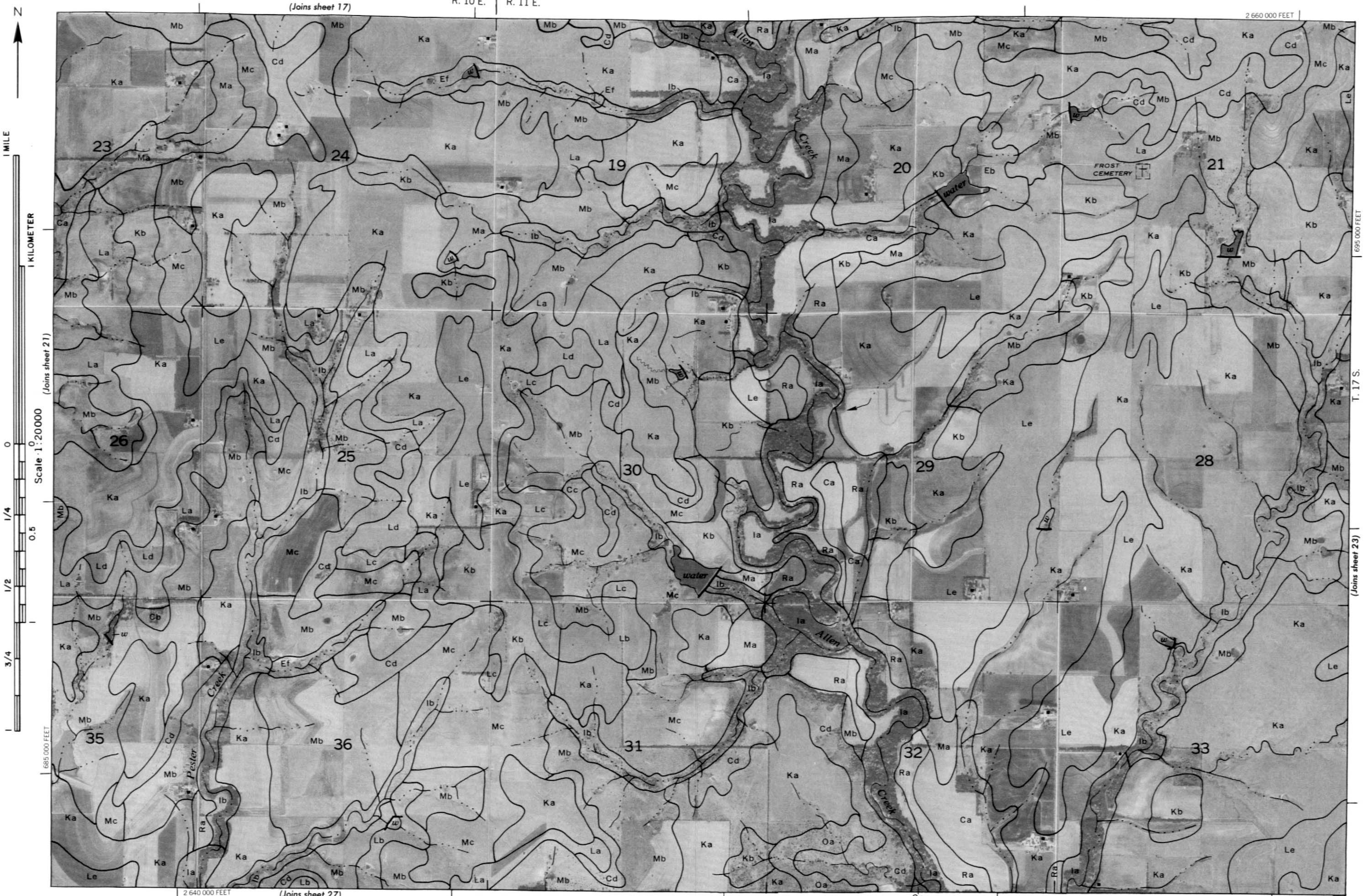

R. 10 E.
R. 11 E.
2 640 000 FEET
(Joins sheet 12)
710 000 FEET
T. 17 S.
(Joins sheet 16)
(Joins sheet 18)
(Joins sheet 22)
700 000 FEET
2 660 000 FEET
Allen Cr.
Allen Creek
N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0
0.5
1


N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0
0.5
(Joins sheet 13)
R. 11 E.
R. 12 E.
2 680 000 FEET
715 000 FEET
T. 17 S.
(Joins sheet 19)
(Joins sheet 17)
(Joins sheet 23)
2 665 000 FEET
700 000 FEET
Duck Creek

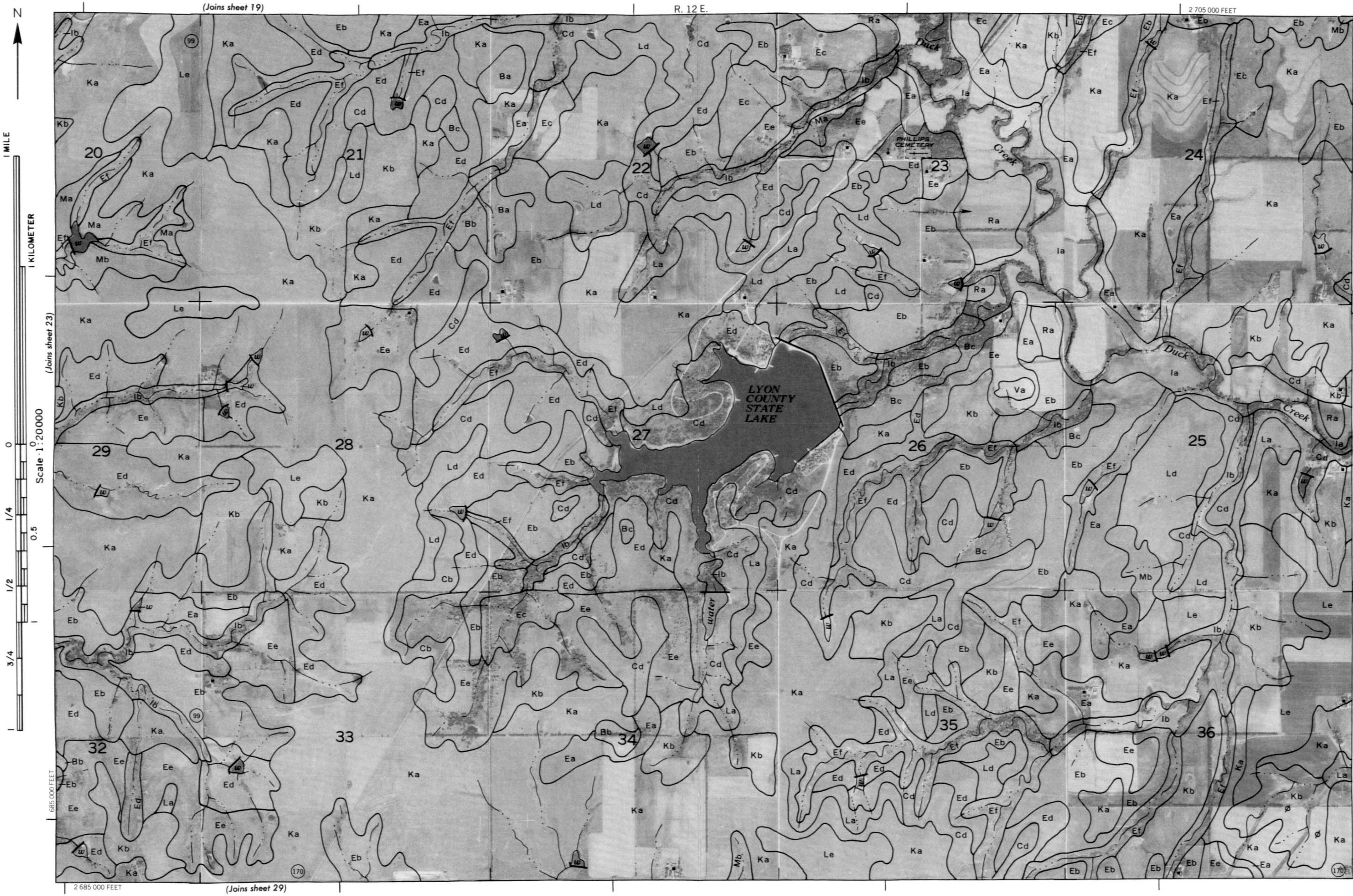

19
N
2 685 000 FEET
R. 12 E.
(Joins sheet 14)
715 000 FEET
T. 17 S.
(Joins sheet 18)
(Joins sheet 20)
705 000 FEET
(Joins sheet 24)
2 705 000 FEET
One Hundred and Forty Mile Creek
Two Hill Creek
Duck Creek
Creek
KANSAS TURNPIKE
TURNPIKE
KANSAS
99
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0.5


20
N
(Joins sheet 15)
(Joins sheet 19)
(Joins sheet 25)
R. 13 E.
T. 17 S.
OSAGE COUNTY
2 730 000 FEET
715 000 FEET
705 000 FEET
2 710 000 FEET
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0.5
ELM CREEK
One Hundred and Forty Two Mile Creek
MARAIS DES CYGNES RIVER

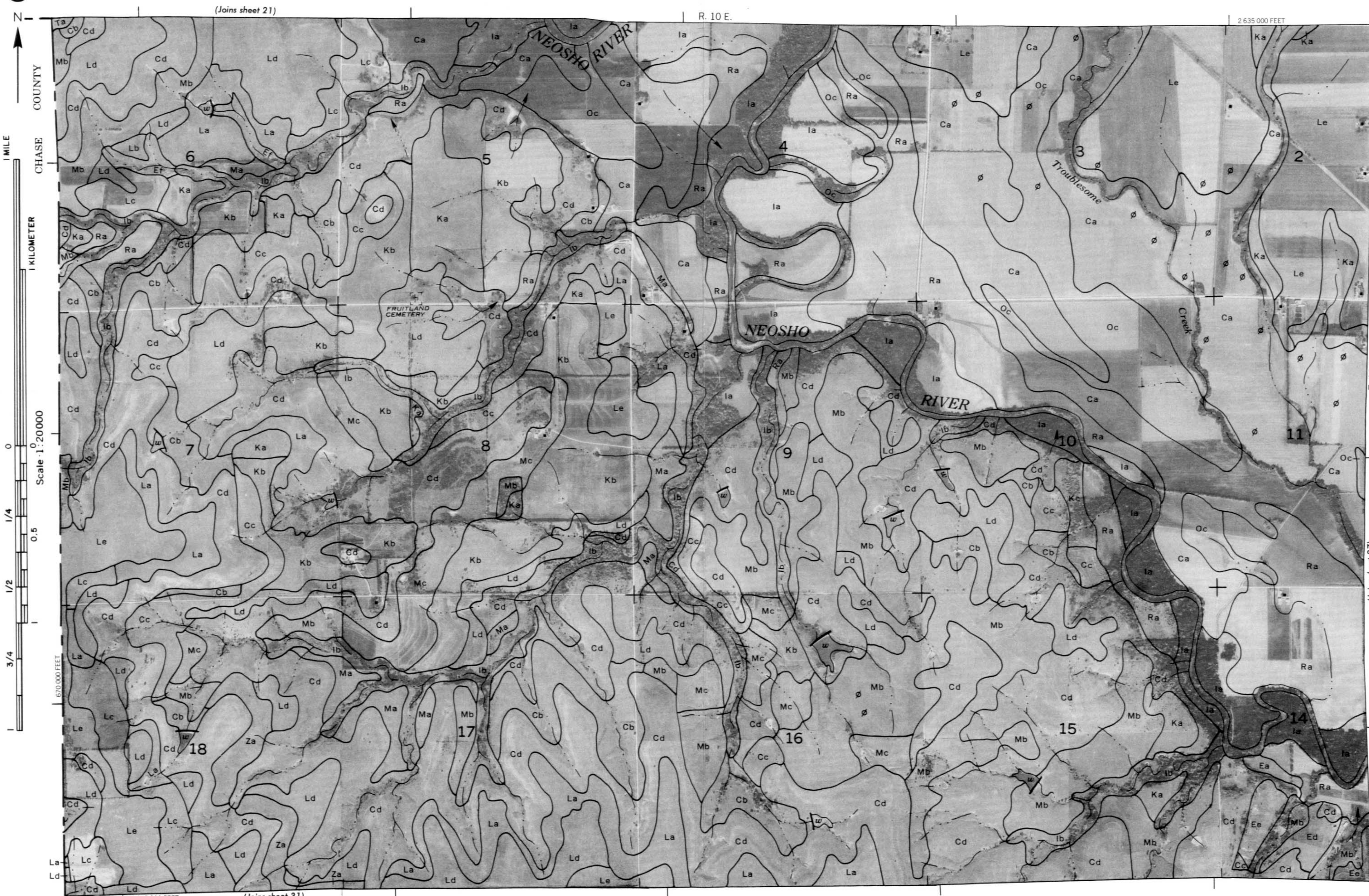
LYON COUNTY, KANSAS — SHEET NUMBER 21


(Joins sheet 17)
R. 10 E.
R. 11 E.
(Joins sheet 21)
(Joins sheet 23)
(Joins sheet 27)
T. 17 S.
2 660 000 FEET
2 640 000 FEET
695 000 FEET
685 000 FEET
FROST CEMETERY
Allen Creek
Pester Creek
N
1 MILE
1 KILOMETER
Scale 1:20000


(Joins sheet 18)
(Joins sheet 24)
(Joins sheet 28)
(Joins sheet 22)
R. 11 E.
R. 12 E.
T. 17 S.
2 665 000 FEET
2 680 000 FEET
695 000 FEET
685 000 FEET
N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0
0.5
1
Dow Creek
Stillman Creek
ROSEAN CEMETERY
LIMESTONE QUARRY
KANSAS TURNPIKE
19
20
22
23
24
25
26
27
29
30
31
32
34
35
36


N
(Joins sheet 19)
R. 12 E.
2 705 000 FEET
700 000 FEET
T. 17 S.
(Joins sheet 25)
(Joins sheet 23)
(Joins sheet 29)
2 685 000 FEET
685 000 FEET
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0
0.5
1
LYON COUNTY STATE LAKE
PHILLIPS CEMETERY
Duck Creek
water
20
21
22
23
24
25
26
27
28
29
32
33
34
35
36
99
170

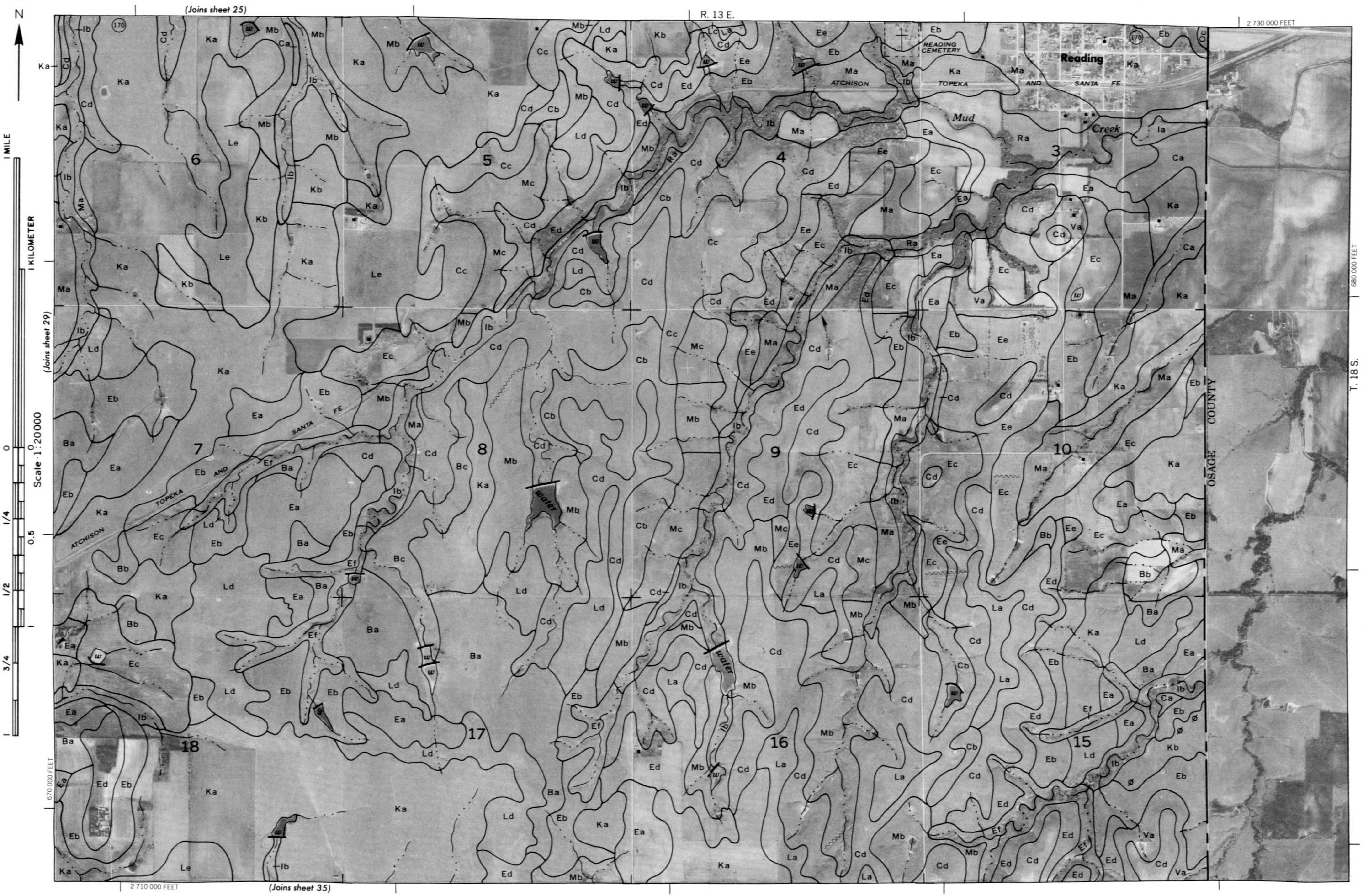

25
(Joins sheet 20)
(Joins sheet 24)
(Joins sheet 30)
R. 13 E.
T. 17 S.
2 710 000 FEET
2 730 000 FEET
700 000 FEET
685 000 FEET
N
1 MILE
1 KILOMETER
Scale 1:20 000
0
1/4
1/2
3/4
0.5
MARAIS DES CYGNES RIVER
One Hundred and Forty Two Mi Cr
Duck Creek
LIMESTONE QUARRY
MT CALVARY CEMETERY
OSAGE COUNTY
Reading
170
19
20
21
22
27
28
29
30
31
32
33
34

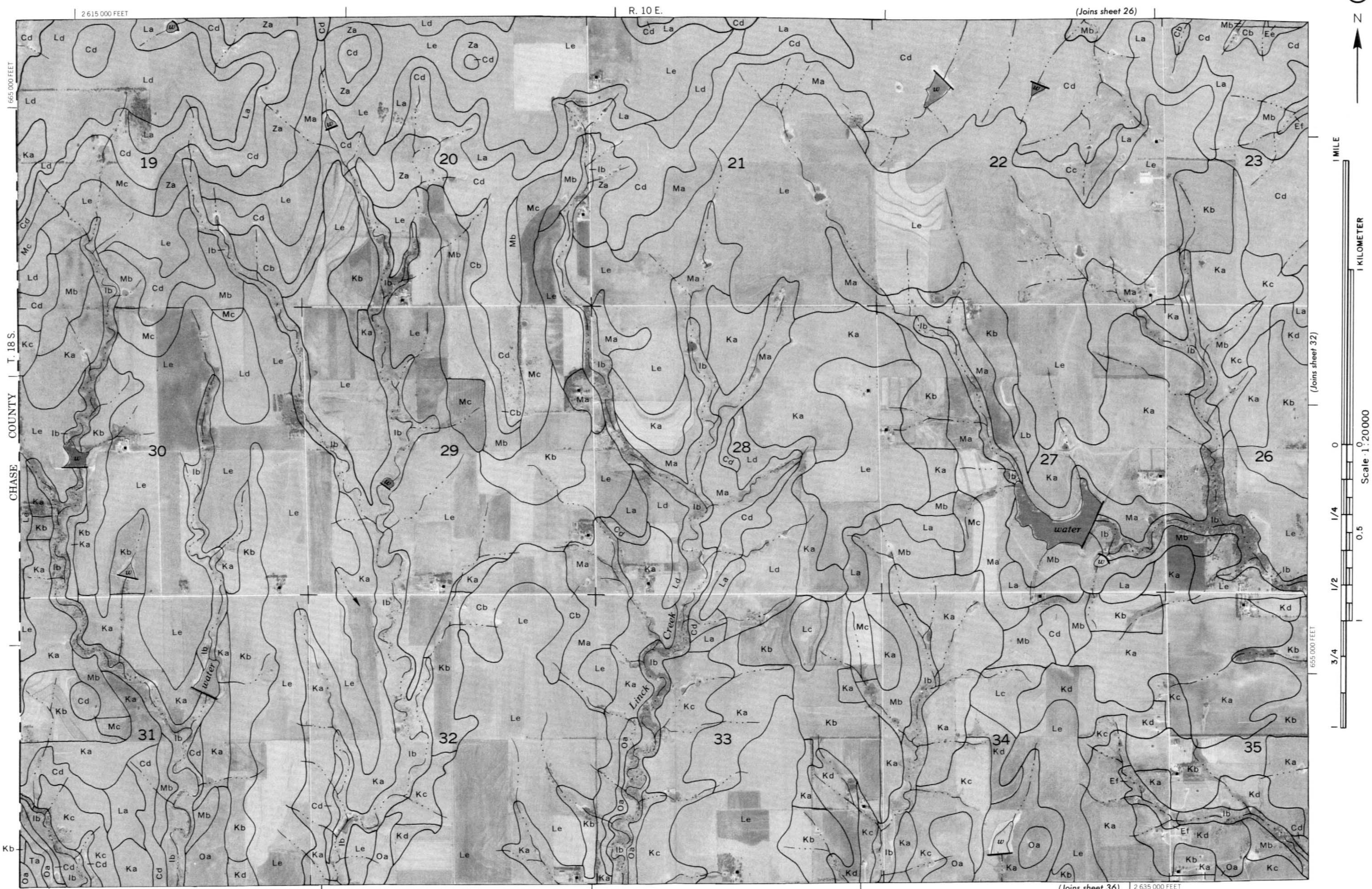

(Joins sheet 21)
R. 10 E.
2 635 000 FEET
CHASE COUNTY
N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0
0.5
1
NEOSHO RIVER
NEOSHO
RIVER
Troublesome
Creek
FRUITLAND CEMETERY
680 000 FEET
T. 18 S.
(Joins sheet 27)
670 000 FEET
2 615 000 FEET
(Joins sheet 31)


R. 10 E.
R. 11 E.
2 640 000 FEET
680 000 FEET
T. 18 S.
(Joins sheet 22)
(Joins sheet 28)
(Joins sheet 32)
(Joins sheet 26)
2 660 000 FEET
670 000 FEET
N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0
0.5
1
Americus
TOWNSHIP CEMETERY
Pestor Cr
Allen Creek
Troublesome Creek
NEOSHO RIVER
Creek
Pestor
1
2
4
5
6
7
8
9
11
12
13
14
16
17
18


N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0
0.5
1
(Joins sheet 23)
(Joins sheet 27)
(Joins sheet 29)
(Joins sheet 33)
R. 11 E.
R. 12 E.
T. 18 S.
2 680 000 FEET
680 000 FEET
670 000 FEET
2 665 000 FEET
Stillman Cr.
Stillman Creek
Taylor Creek
KANSAS TURNPIKE
water


R. 12 E.
(Joins sheet 24)
2 685 000 FEET
680 000 FEET
T. 18 S.
(Joins sheet 28)
(Joins sheet 30)
670 000 FEET
(Joins sheet 34)
2 705 000 FEET
Badger Creek
Plumb Creek
Badger Creek
water
ATCHISON TOPEKA AND SANTA FE
N
1 MILE
1 KILOMETER
Scale 1:20 000
0
1/4
1/2
3/4
0
0.5

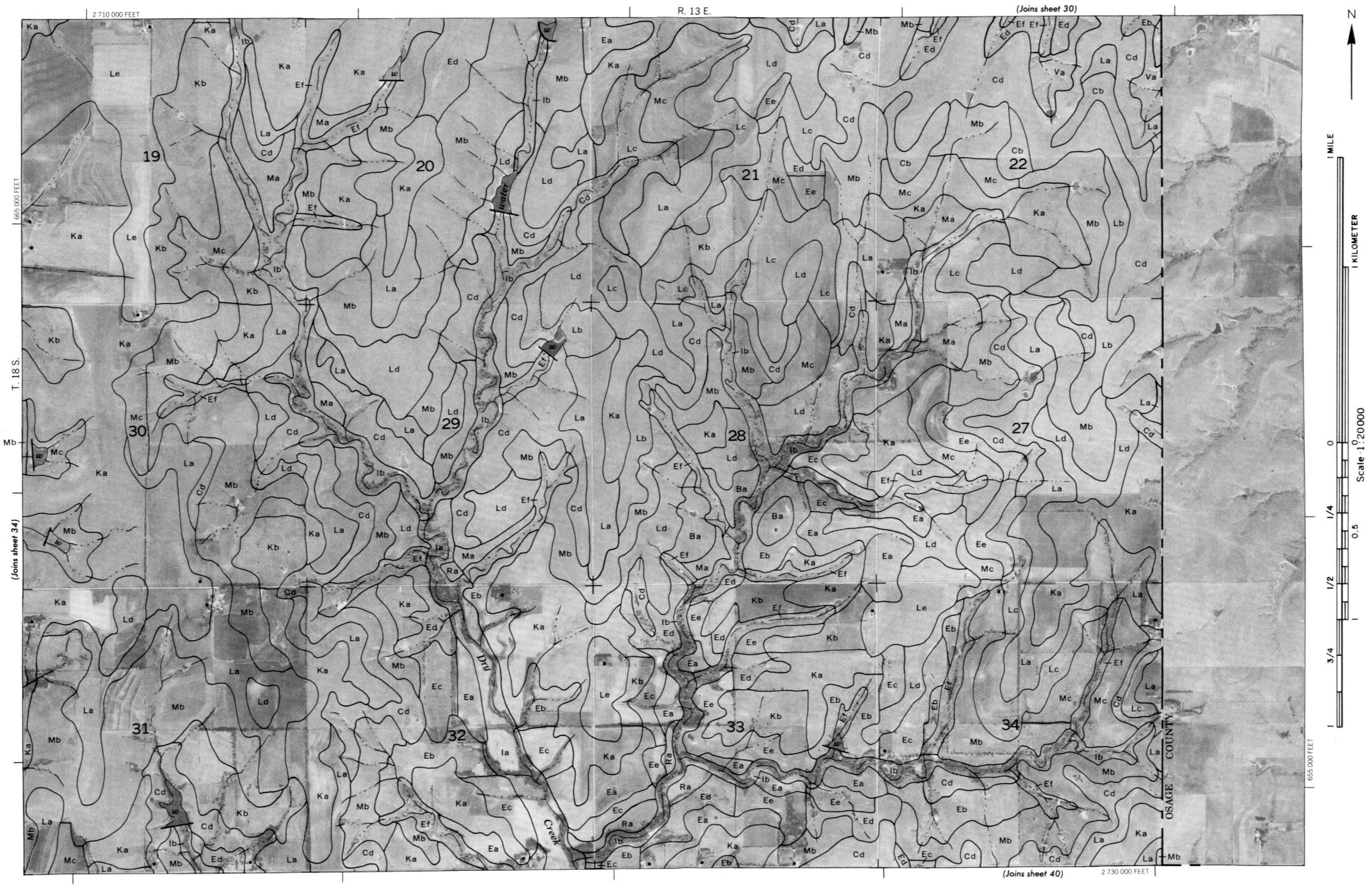

N
1 MILE
1 KILOMETER
Scale 1:20000
(Joins sheet 25)
R. 13 E.
2 730 000 FEET
READING CEMETERY
Reading
ATCHISON TOPEKA AND SANTA FE
Mud Creek
680 000 FEET
T. 18 S.
OSAGE COUNTY
(Joins sheet 29)
670 000 FEET
2 710 000 FEET
(Joins sheet 35)
170
water
3
4
5
6
7
8
9
10
15
16
17
18


2 615 000 FEET
R. 10 E.
(Joins sheet 26)
665 000 FEET
T. 18 S.
CHASE COUNTY
(Joins sheet 32)
655 000 FEET
(Joins sheet 36)
2 635 000 FEET
19
20
21
22
23
30
29
28
27
26
31
32
33
34
35
Linck Creek
water
N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5


32
N
(Joins sheet 27)
R. 10 E.
R. 11 E.
2 660 000 FEET
665 000 FEET
T. 18 S.
(Joins sheet 31)
(Joins sheet 33)
(Joins sheet 37)
655 000 FEET
2 640 000 FEET
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0
0.5
NEOSHO
RIVER
Troublesome
Creek
Allen
Moon
KANSAS
TURNPIKE
19
20
21
23
24
25
26
28
29
30
31
32
33
35
36


(Joins sheet 28)
(Joins sheet 32)
(Joins sheet 34)
(Joins sheet 38)
R. 11 E. | R. 12 E.
T. 18 S.
2 665 000 FEET
2 685 000 FEET
665 000 FEET
655 000 FEET
N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0
0.5
1
Stillman
Dow Creek
Taylor Creek
Plumb Creek
Allen Creek
TURNPIKE
KANSAS
99
water
int
19
20
22
23
24
25
26
27
29
30
31
32
34
35
36


N
1 MILE
1 KILOMETER
Scale 1:20000
(Joins sheet 29)
R. 12 E.
2 705 000 FEET
655 000 FEET
T. 18 S.
(Joins sheet 33)
(Joins sheet 35)
(Joins sheet 39)
2 690 000 FEET
ATCHISON TOPEKA AND SANTA FE
Badger Cr.
Badger Creek
Camp Cr.
UNION CEMETERY
water
20
21
22
23
24
25
26
27
28
29
32
33
34
35
36

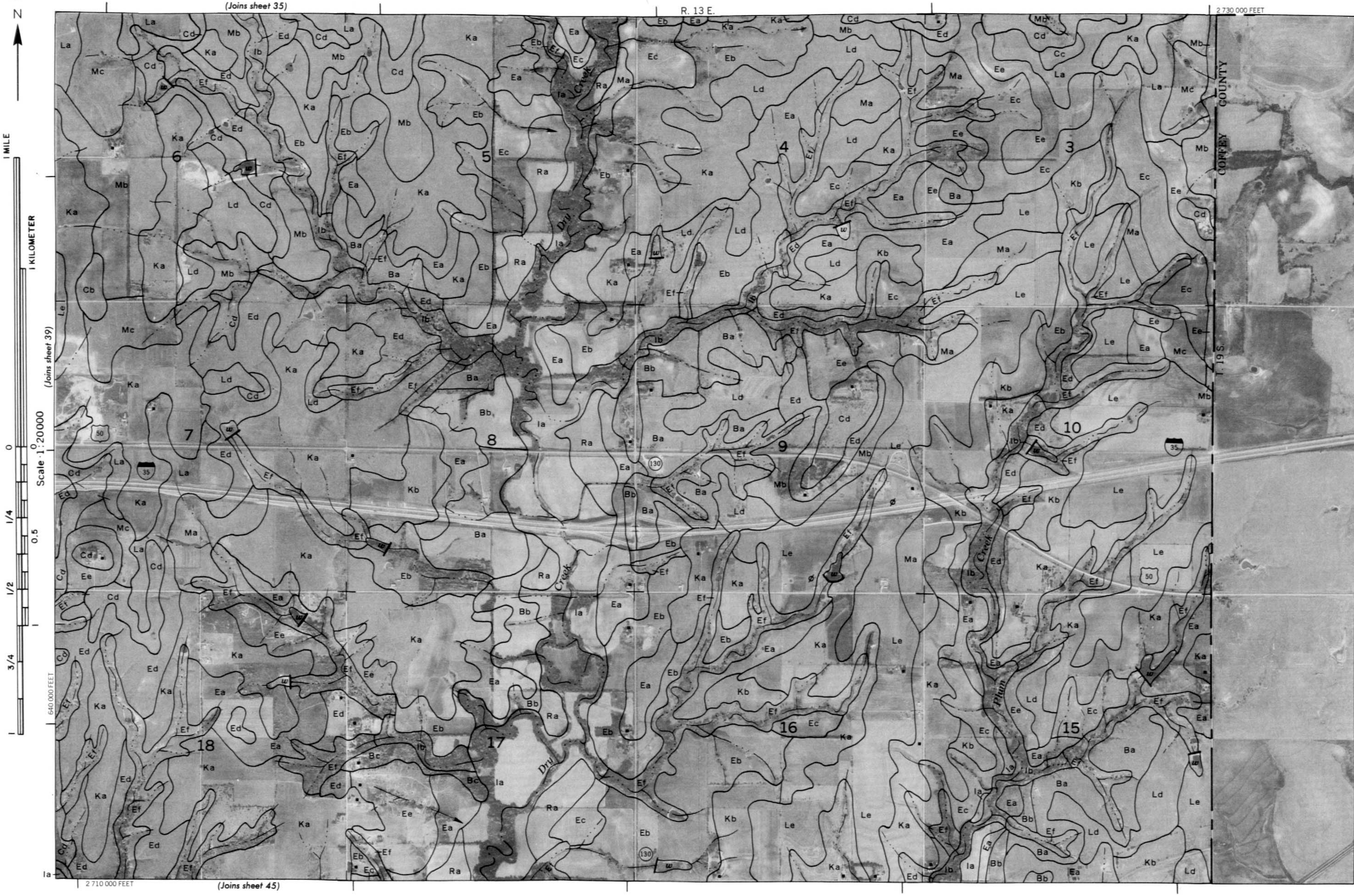

(Joins sheet 30)
(Joins sheet 34)
(Joins sheet 40)
R. 13 E.
T. 18 S.
2 710 000 FEET
2 730 000 FEET
665 000 FEET
655 000 FEET
OSAGE COUNTY
Dry Creek
water
N
1 MILE
1 KILOMETER
Scale 1:20000

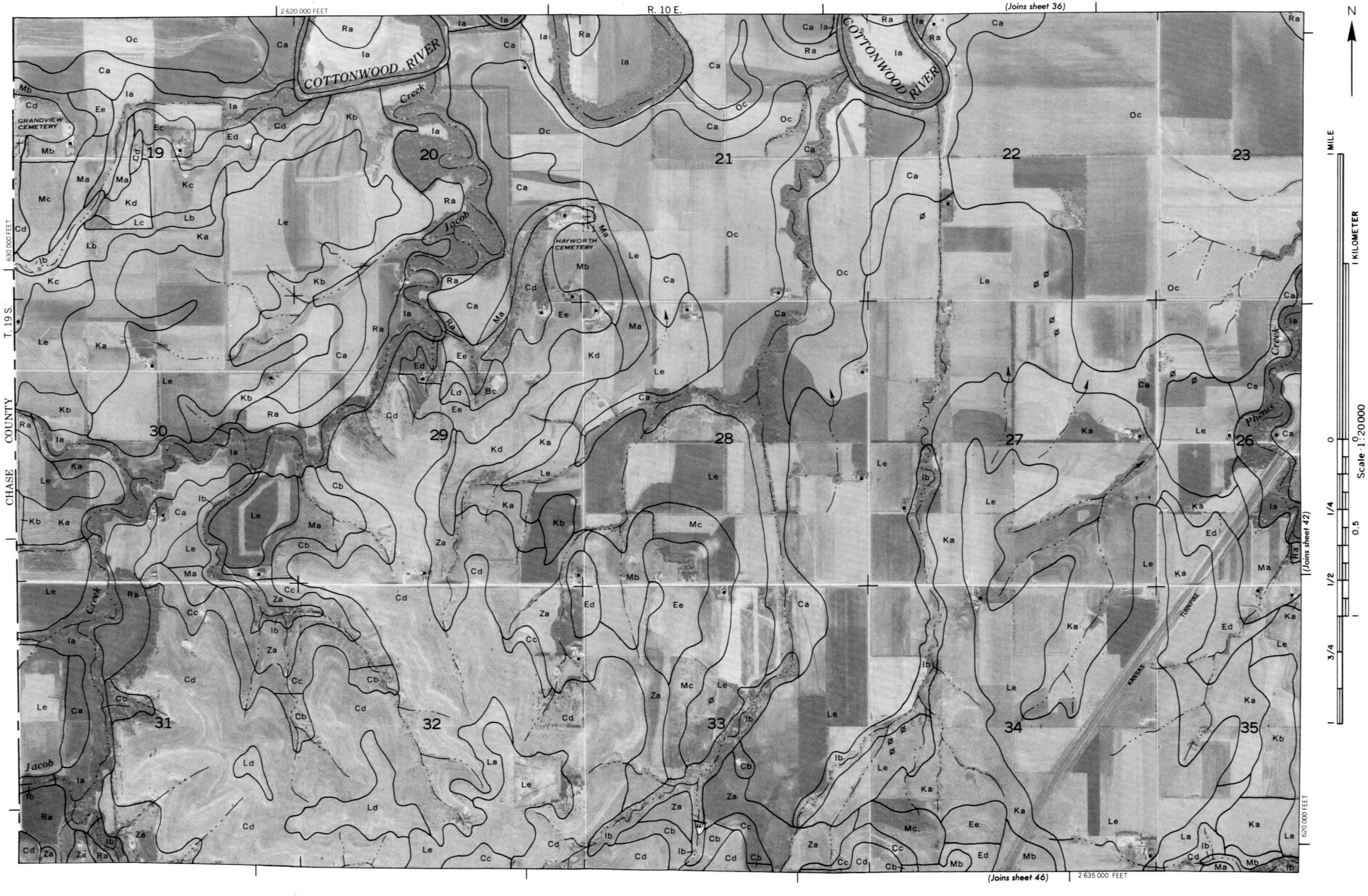

N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0
0.5
(Joins sheet 31)
R. 10 E.
2 635 000 FEET
650 000 FEET
T. 19 S.
(Joins sheet 37)
(Joins sheet 41)
2 620 000 FEET
635 000 FEET
CHASE COUNTY
Beaver Creek
Linck Creek
Ludy Creek
Plymouth
Cottonwood Church
ATCHISON TOPEKA AND SANTA FE
COTTONWOOD RIVER
1
2
3
4
5
6
7
8
9
10
11
14
15
16
17
18


37
N
(Joins sheet 32)
(Joins sheet 38)
(Joins sheet 42)
(Joins sheet 36)
2 640 000 FEET
2 660 000 FEET
650 000 FEET
640 000 FEET
R. 10 E.
R. 11 E.
T. 19 S.
EMPORIA
(county seat)
MEMORIAL LAWN CEMETERY
MAPLEWOOD CEMETERY
NEOSHO
RIV
COTTONWOOD
RIVER
Moon Creek
ATCHISON TOPEKA AND SANTA FE
TURNPIKE
KANSAS
water
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5

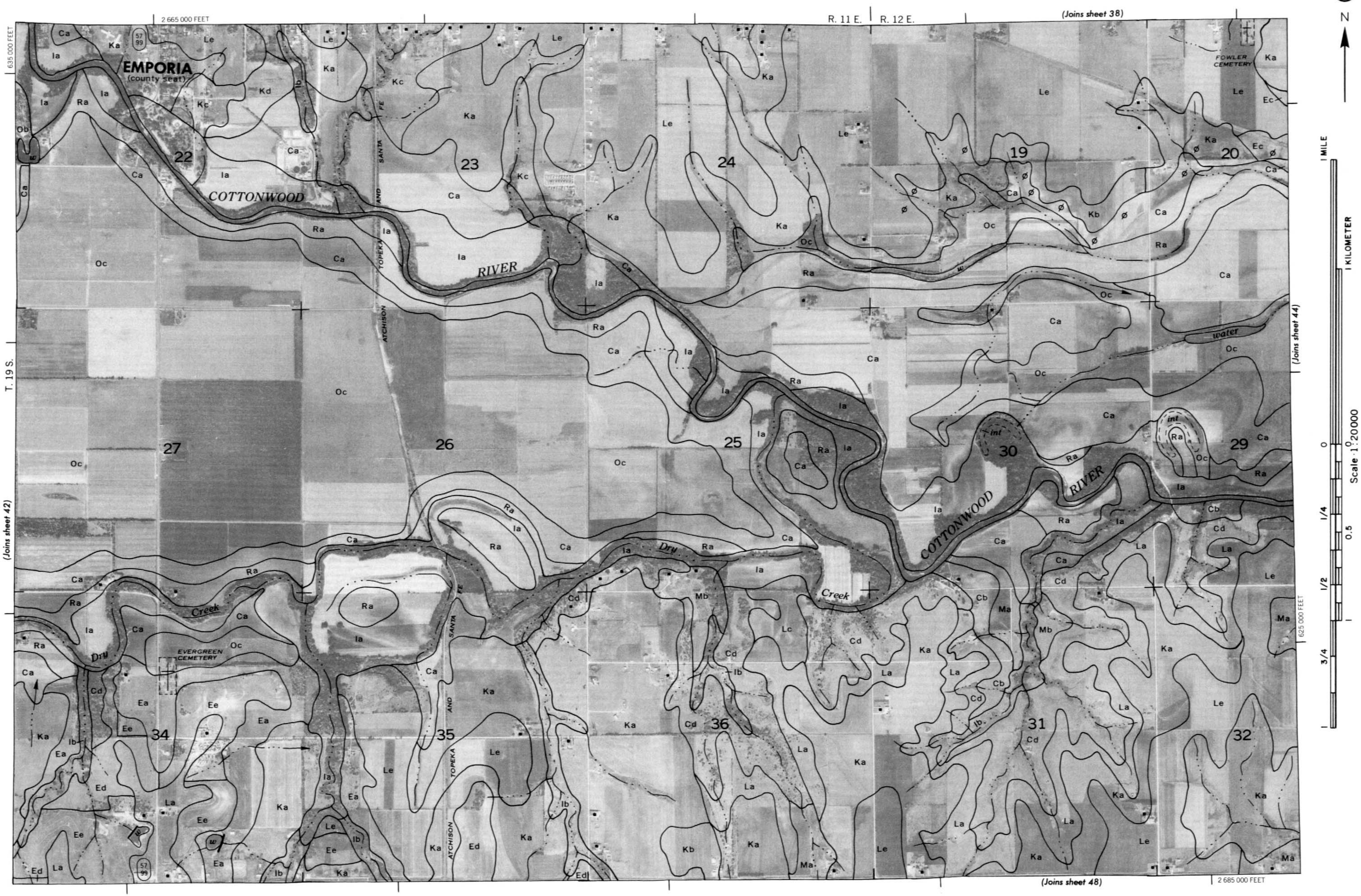

(Joins sheet 33)
R. 11 E.
R. 12 E.
2 685 000 FEET
650 000 FEET
T. 19 S.
(Joins sheet 39)
(Joins sheet 37)
640 000 FEET
2 665 000 FEET
(Joins sheet 43)
N
1 MILE
1 KILOMETER
Scale 1:20000
NEOSHO
RIVER
Taylor Cr
Plum Creek
EMPORIA STATE UNIVERSITY
EMPORIA
(county seat)
ATCHISON TOPEKA AND SANTA FE
SACRED HEART CEMETERY
water


2 690 000 FEET
R. 12 E.
(Joins sheet 34)
650 000 FEET
T. 19 S.
(Joins sheet 38)
(Joins sheet 40)
(Joins sheet 44)
2 705 000 FEET
640 000 FEET
N
1 MILE
1 KILOMETER
Scale 1:20000
Coon Creek
Badger Creek
NEOSHO RIVER
HUNTER CEMETERY
BADGER CREEK CEMETERY
water
A T & S F
50
35

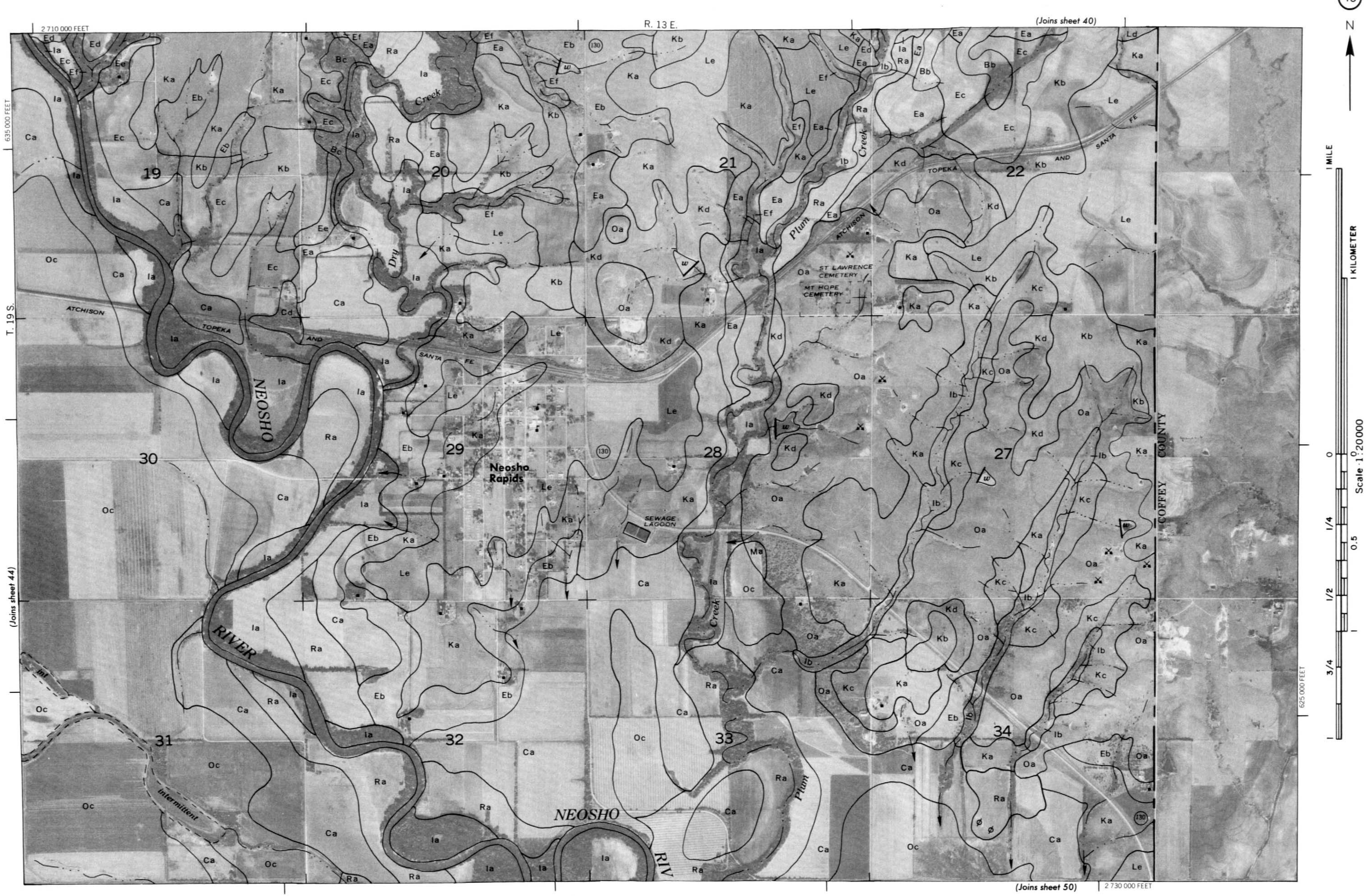

N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0
0.5
1
(Joins sheet 35)
R. 13 E.
2 730 000 FEET
COFFEY COUNTY
T. 19 S.
650 000 FEET
(Joins sheet 39)
640 000 FEET
(Joins sheet 45)
2 710 000 FEET
Dry Creek
Plum Creek
35
50
130

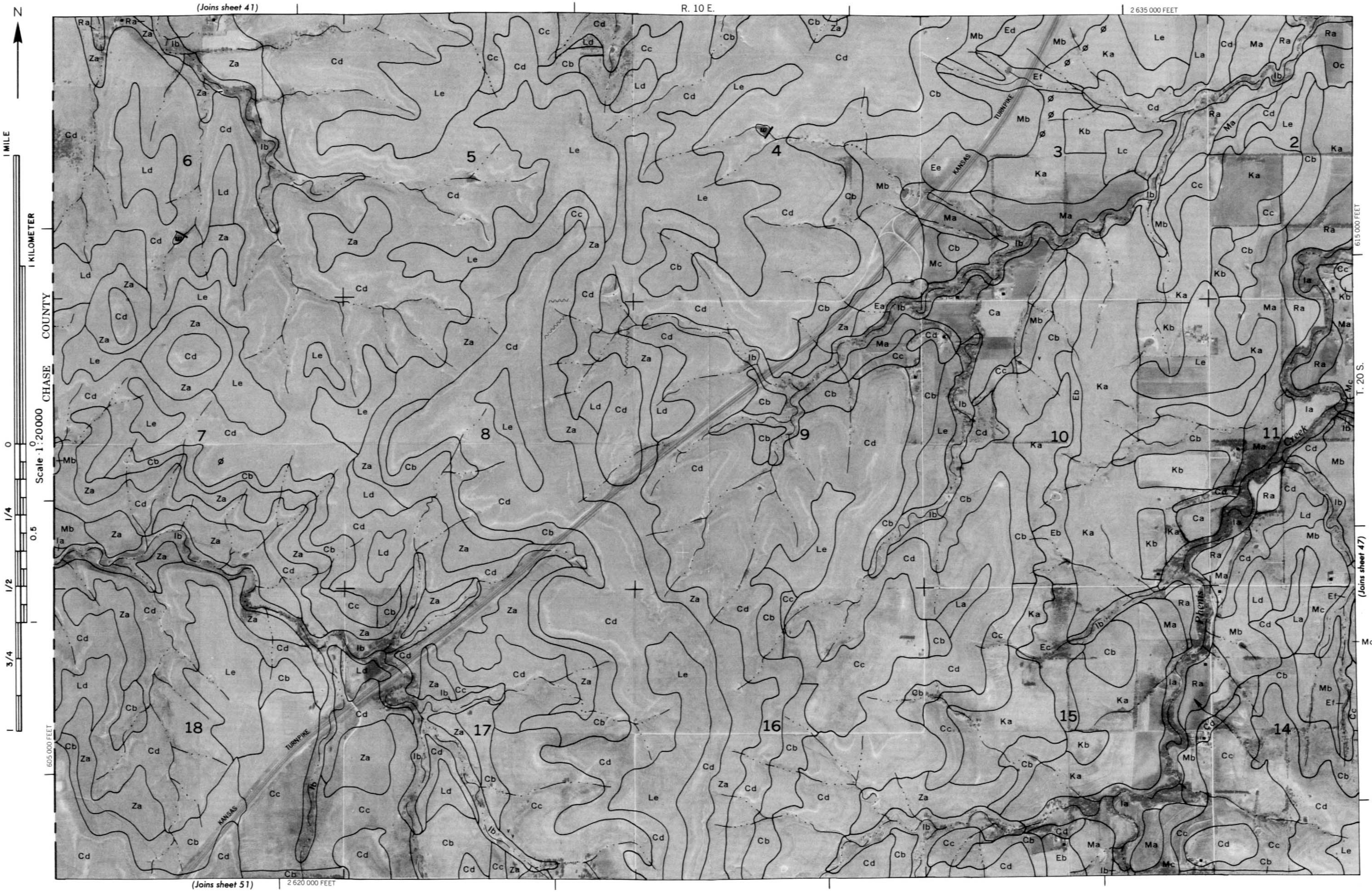

2 620 000 FEET
R. 10 E.
(Joins sheet 36)
COTTONWOOD RIVER
COTTONWOOD RIVER
Creek
Jacob
GRANDVIEW CEMETERY
HAYWORTH CEMETERY
630 000 FEET
T. 19 S.
CHASE COUNTY
19
20
21
22
23
30
29
28
27
26
31
32
33
34
35
Phenis
Creek
Jacob
Creek
Jacob
KANSAS TURNPIKE
(Joins sheet 42)
620 000 FEET
(Joins sheet 46)
2 635 000 FEET
N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0
0.5
1

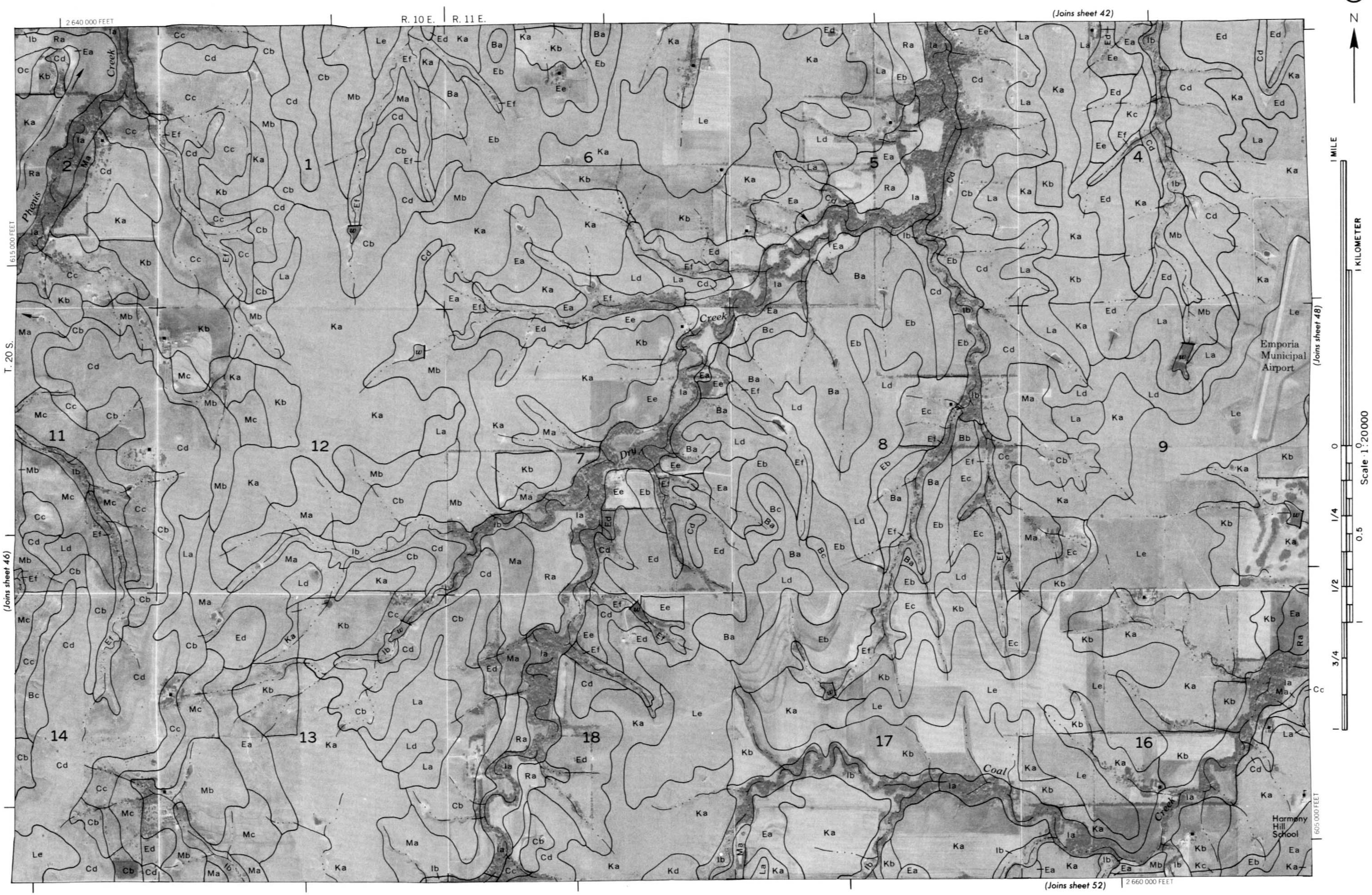

(Joins sheet 37)
R. 10 E.
R. 11 E.
2 660 000 FEET
635 000 FEET
T. 19 S.
(Joins sheet 43)
(Joins sheet 47)
2 640 000 FEET
620 000 FEET
(Joins sheet 41)
N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0.5
COTTONWOOD RIVER
KANSAS TURNPIKE
Pheuis Cr
Dry Creek
GREENWOOD CEMETERY
intermittent
water
35
19
20
21
23
24
25
26
28
29
30
31
32
33
36


2 665 000 FEET
635 000 FEET
R. 11 E.
R. 12 E.
(Joins sheet 38)
EMPORIA
(county seat)
FOWLER CEMETERY
COTTONWOOD
RIVER
ATCHISON
TOPEKA
AND
SANTA
FE
T. 19 S.
(Joins sheet 42)
(Joins sheet 44)
(Joins sheet 48)
water
Dry
Creek
EVERGREEN CEMETERY
22
23
24
19
20
27
26
25
30
29
34
35
36
31
32
625 000 FEET
2 685 000 FEET
N
1 MILE
1 KILOMETER
Scale 1:20 000

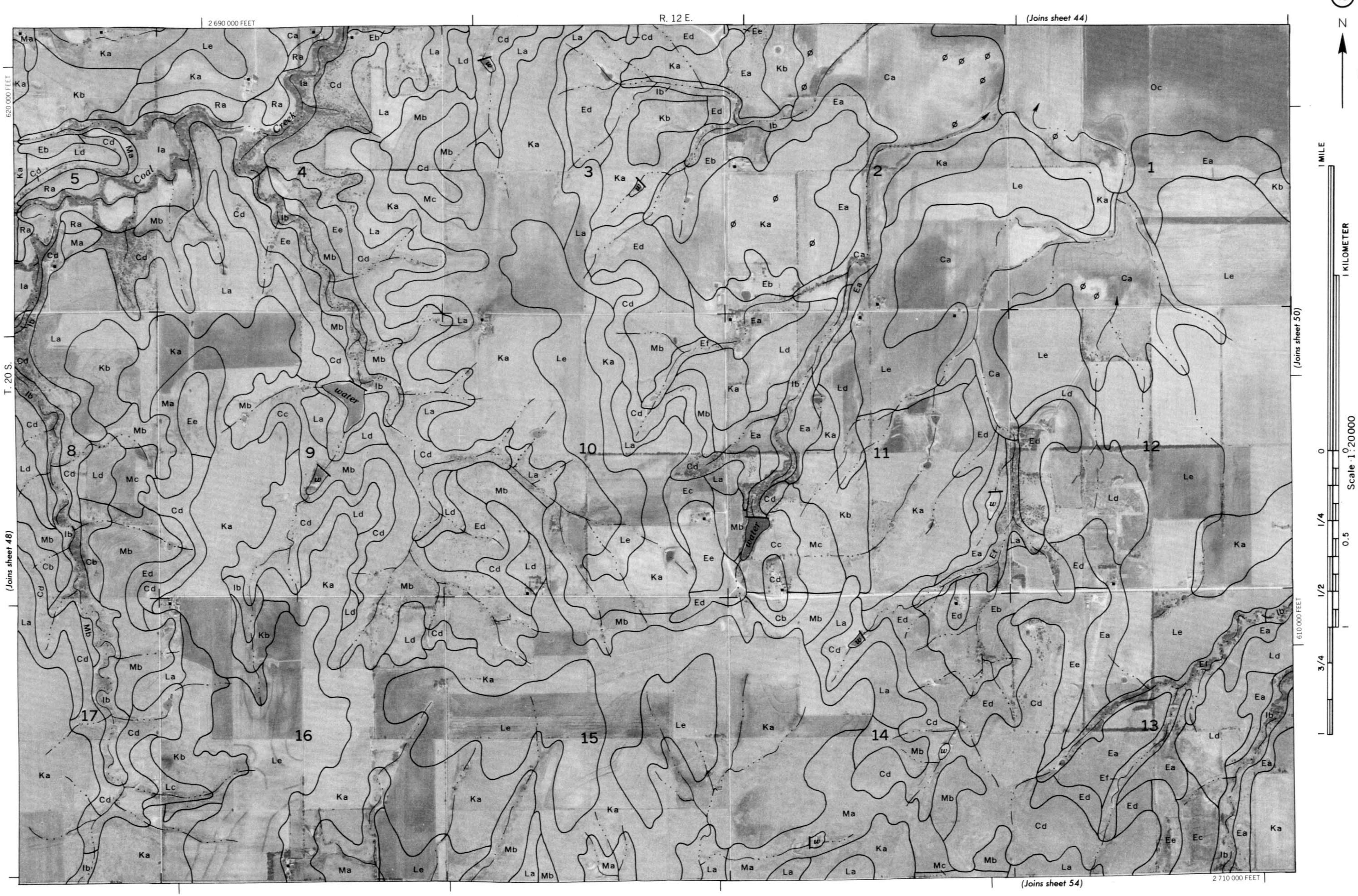

N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0
0.5
1
(Joins sheet 39)
R. 12 E.
2 705 000 FEET
635 000 FEET
(Joins sheet 43)
T. 19 S.
(Joins sheet 45)
625 000 FEET
2 690 000 FEET
(Joins sheet 49)
ATCHISON TOPEKA AND SANTA FE
NEOSHO RIVER
NEOSHO RIVER
COTTONWOOD RIVER
COTTONWOOD RIVER
Coal Creek
CHICAGO MOUND CEMETERY
intermittent
int
20
21
22
23
24
25
26
27
28
29
32
33
34
35
36

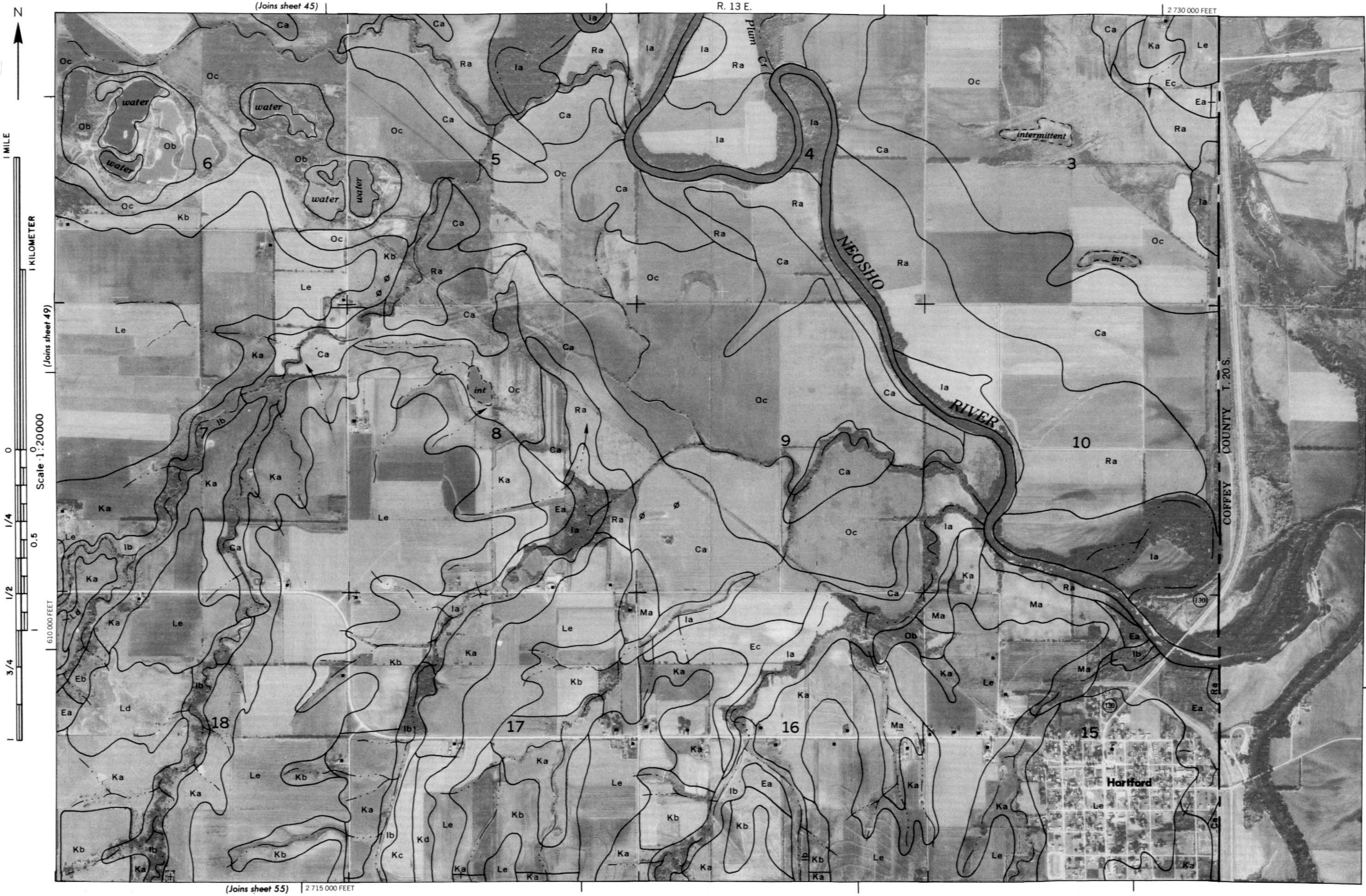

45
N
2 710 000 FEET
R. 13 E.
(Joins sheet 40)
635 000 FEET
T. 19 S.
(Joins sheet 44)
(Joins sheet 50)
2 730 000 FEET
625 000 FEET
COFFEY COUNTY
1 MILE
1 KILOMETER
Scale 1:20 000
0
1/4
1/2
3/4
0.5
19
20
21
22
27
28
29
30
31
32
33
34
Neosho Rapids
NEOSHO RIVER
NEOSHO
RIVER
Dry Creek
Plum Creek
Creek
Plum
ATCHISON TOPEKA AND SANTA FE
ST LAWRENCE CEMETERY
MT HOPE CEMETERY
SEWAGE LAGOON
intermittent
Int
130

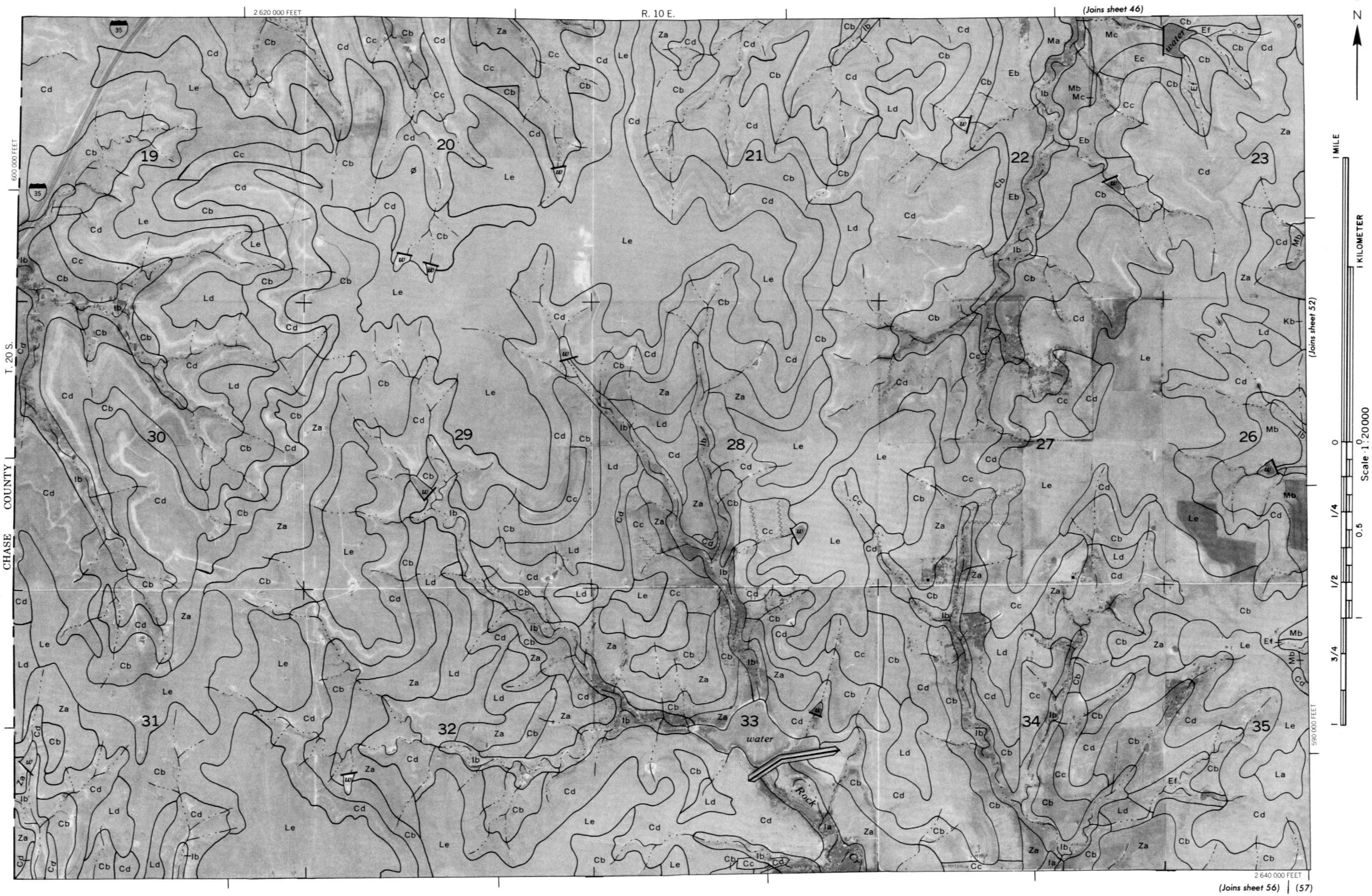

N
(Joins sheet 41)
R. 10 E.
2 635 000 FEET
615 000 FEET
T. 20 S.
(Joins sheet 47)
(Joins sheet 51)
2 620 000 FEET
605 000 FEET
CHASE COUNTY
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0.5
KANSAS TURNPIKE
Phenis Creek
1
2
3
4
5
6
7
8
9
10
11
14
15
16
17
18


47
(Joins sheet 42)
R. 10 E.
R. 11 E.
2 640 000 FEET
615 000 FEET
T. 20 S.
(Joins sheet 46)
(Joins sheet 48)
(Joins sheet 52)
2 660 000 FEET
605 000 FEET
Phenis Creek
Dry Creek
Coal Creek
Emporia Municipal Airport
Harmony Hill School
N
1 MILE
1 KILOMETER
Scale 1:20000


N
(Joins sheet 43)
(Joins sheet 47)
(Joins sheet 49)
(Joins sheet 53)
R. 11 E.
R. 12 E.
T. 20 S.
2 685 000 FEET
620 000 FEET
605 000 FEET
2 665 000 FEET
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0
0.5
1
Emporia Municipal Airport
ATCHISON TOPEKA AND SANTA FE
Coal Creek
Creek
water
1
2
3
5
6
7
8
10
11
12
13
14
15
17
18

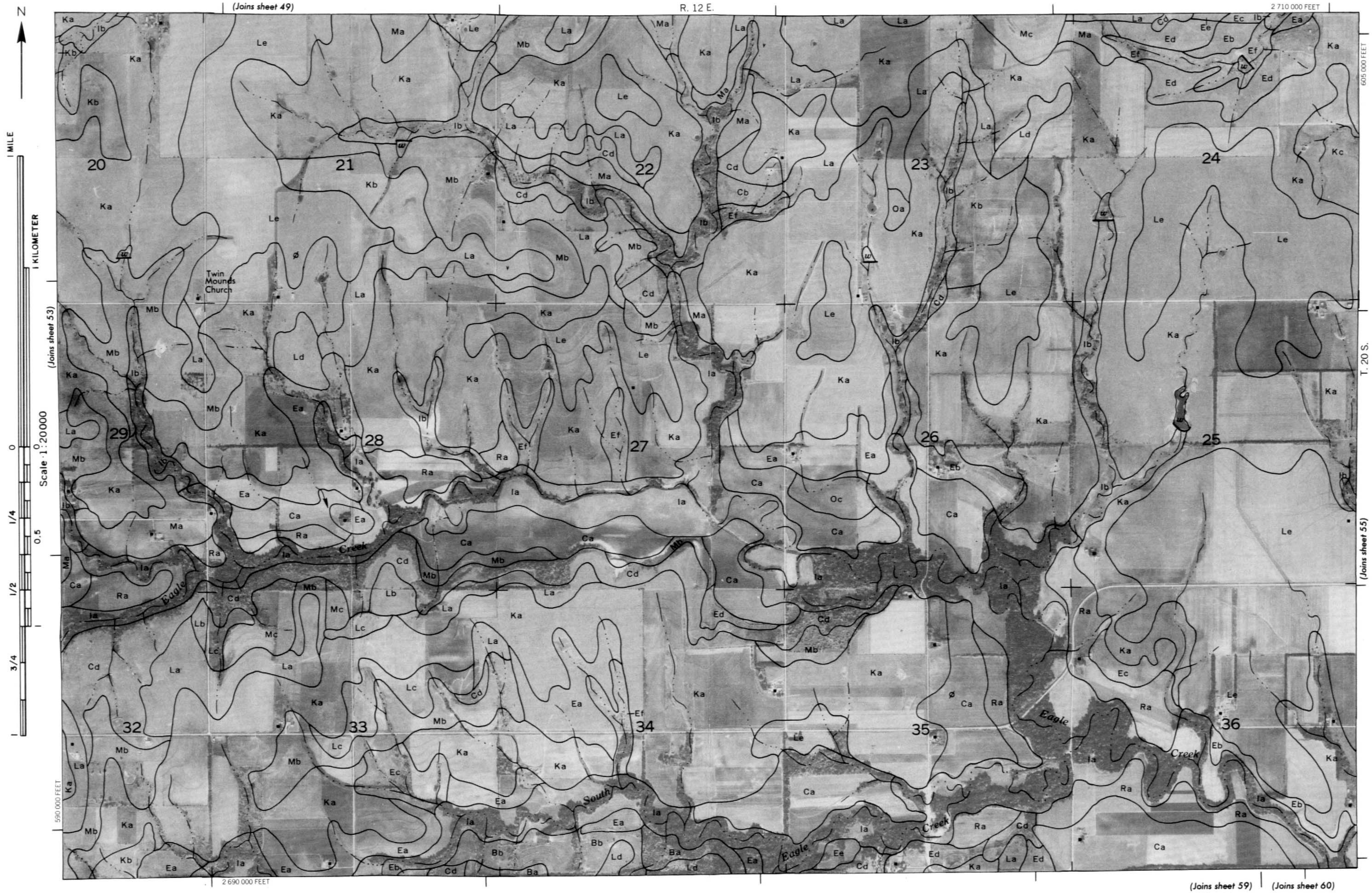

49
2 690 000 FEET
R. 12 E.
(Joins sheet 44)
620 000 FEET
T. 20 S.
(Joins sheet 48)
(Joins sheet 50)
610 000 FEET
(Joins sheet 54)
2 710 000 FEET
N
1 MILE
1 KILOMETER
Scale 1:20000
Coal
Creek
water


N
(Joins sheet 45)
R. 13 E.
2 730 000 FEET
620 000 FEET
(Joins sheet 49)
610 000 FEET
(Joins sheet 55)
2 715 000 FEET
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0
0.5
1
NEOSHO
RIVER
Plum Cr
COFFEY COUNTY
T. 20 S.
Hartford
water
intermittent
int
130


51
N
2 620 000 FEET
R. 10 E.
(Joins sheet 46)
600 000 FEET
T. 20 S.
CHASE COUNTY
(Joins sheet 52)
590 000 FEET
2 640 000 FEET
(Joins sheet 56)
(57)
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0
0.5
19
20
21
22
23
26
27
28
29
30
31
32
33
34
35
water
Rock Cr.

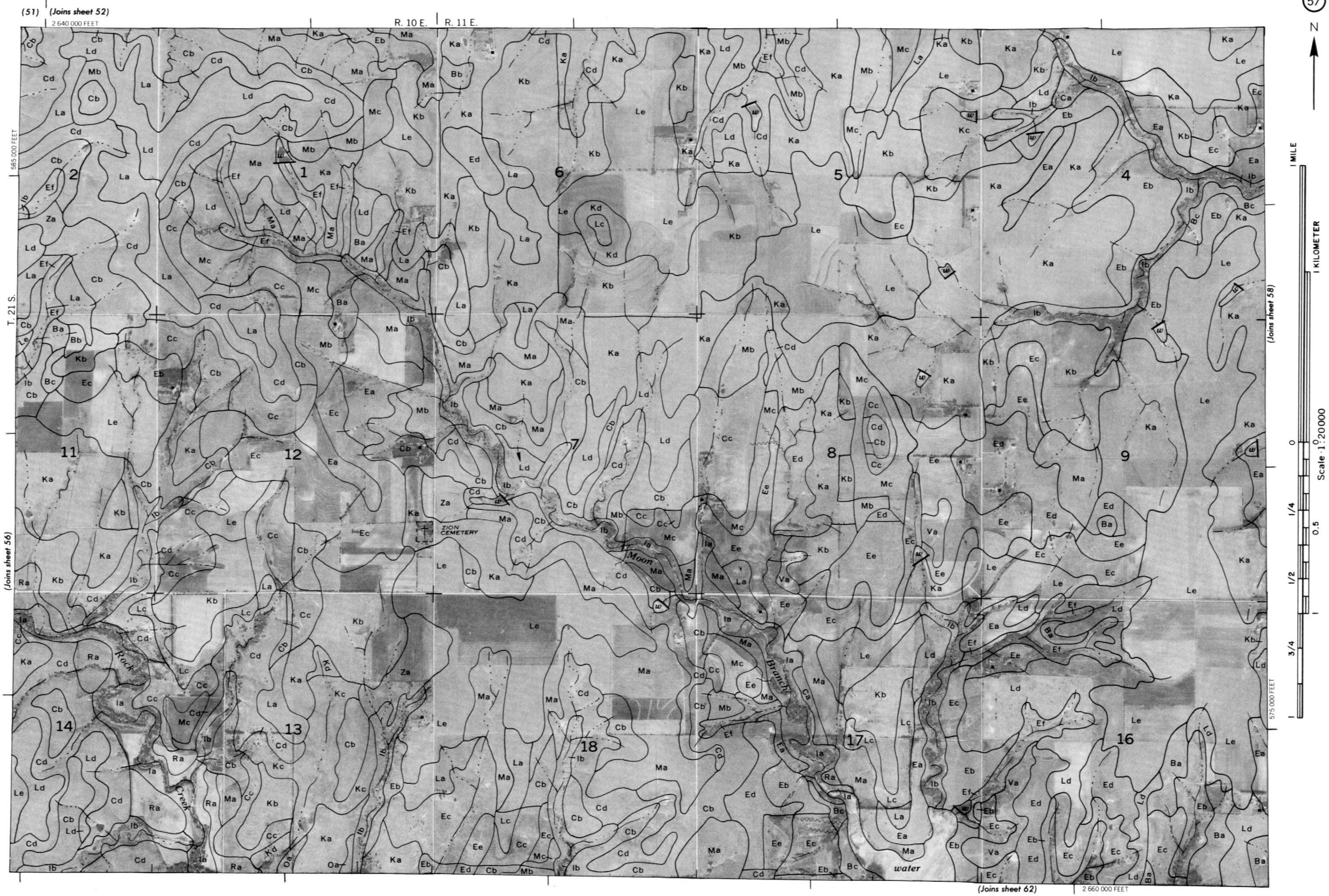

N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0
0.5
(Joins sheet 47)
R. 10 E.
R. 11 E.
2 660 000 FEET
600 000 FEET
T. 20 S.
(Joins sheet 51)
(Joins sheet 53)
590 000 FEET
2 645 000 FEET
(Joins sheet 57)
(Joins 58)
19
20
21
23
24
25
26
28
29
30
31
32
33
35
36
Eagle Creek
Eagle
Creek
Ebenezer Church

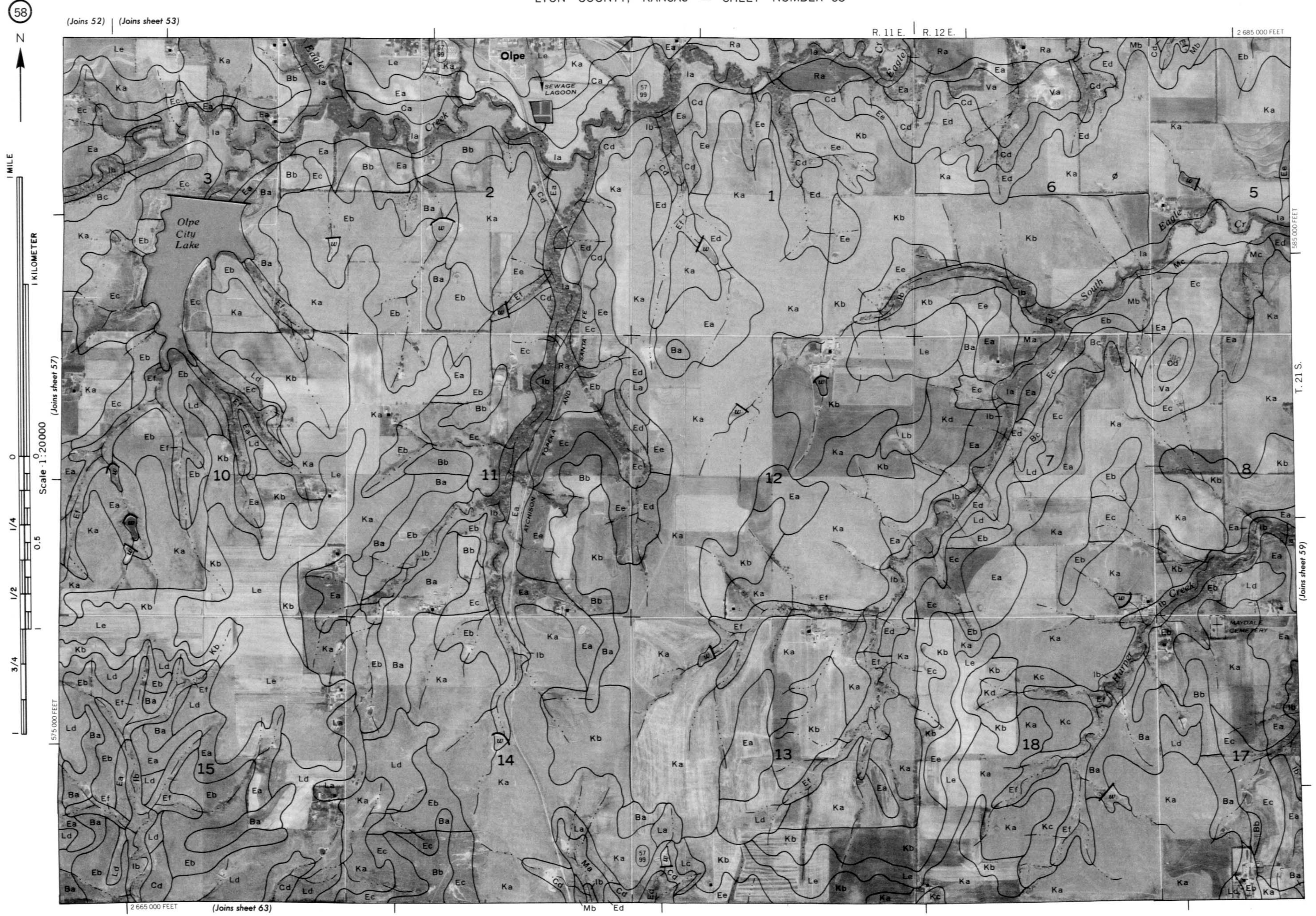

53
N
2 665 000 FEET
R. 11 E.
R. 12 E.
(Joins sheet 48)
600 000 FEET
T. 20 S.
(Joins sheet 52)
(Joins sheet 54)
590 000 FEET
2 685 000 FEET
(Joins sheet 58)
(Joins sheet 59)
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0
0.5
ATCHISON TOPEKA AND SANTA FE
water
Eagle Creek
Olpe
ST JOSEPH CEMETERY
OLPE CEMETERY
19
20
22
23
24
25
26
27
29
30
31
32
34
35
36

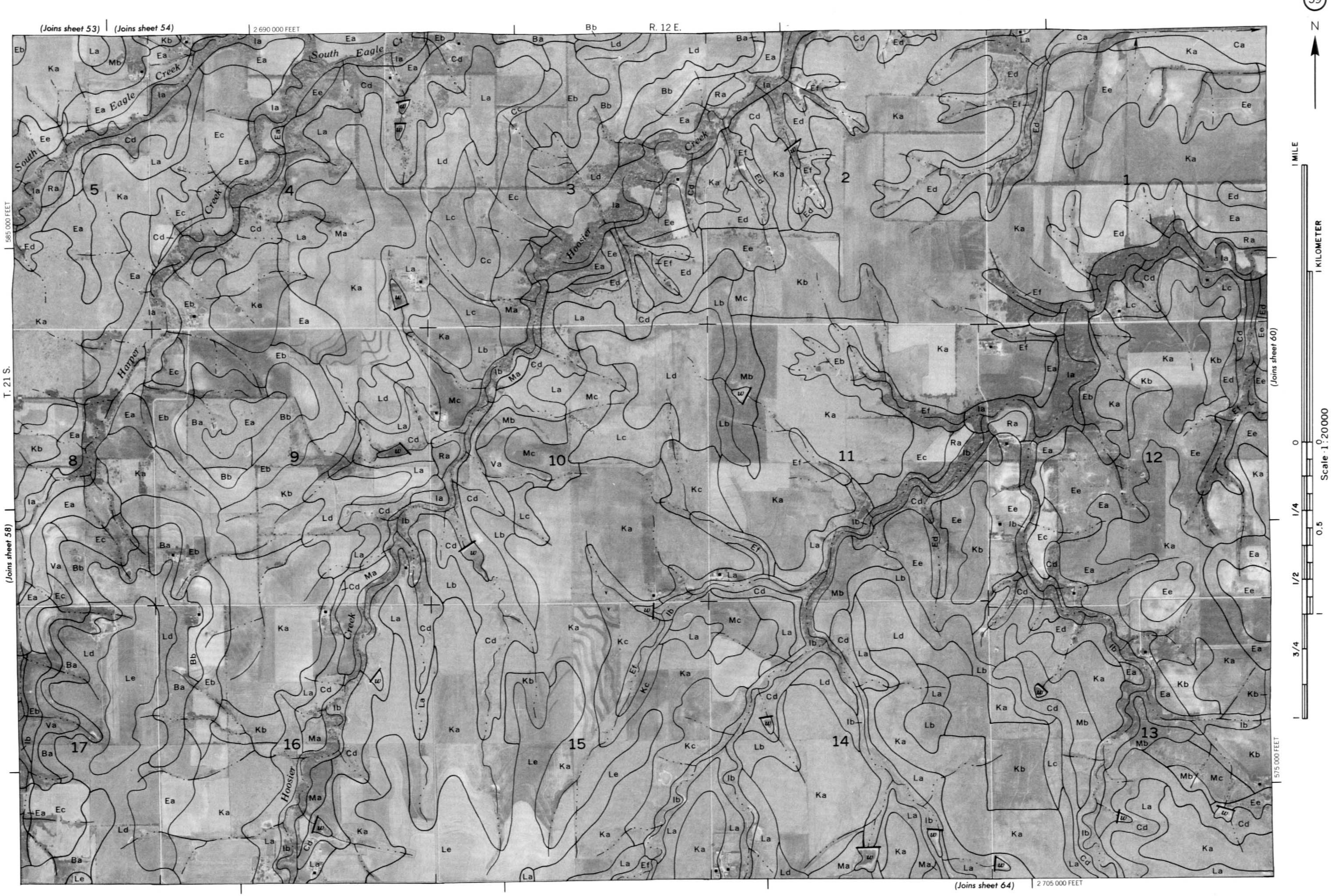

N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
0.5
1/2
3/4
1
(Joins sheet 49)
R. 12 E.
2 710 000 FEET
605 000 FEET
T. 20 S.
(Joins sheet 53)
(Joins sheet 55)
(Joins sheet 59)
(Joins sheet 60)
590 000 FEET
2 690 000 FEET
Twin Mounds Church
Eagle Creek
South Eagle Creek
20
21
22
23
24
25
26
27
28
29
32
33
34
35
36

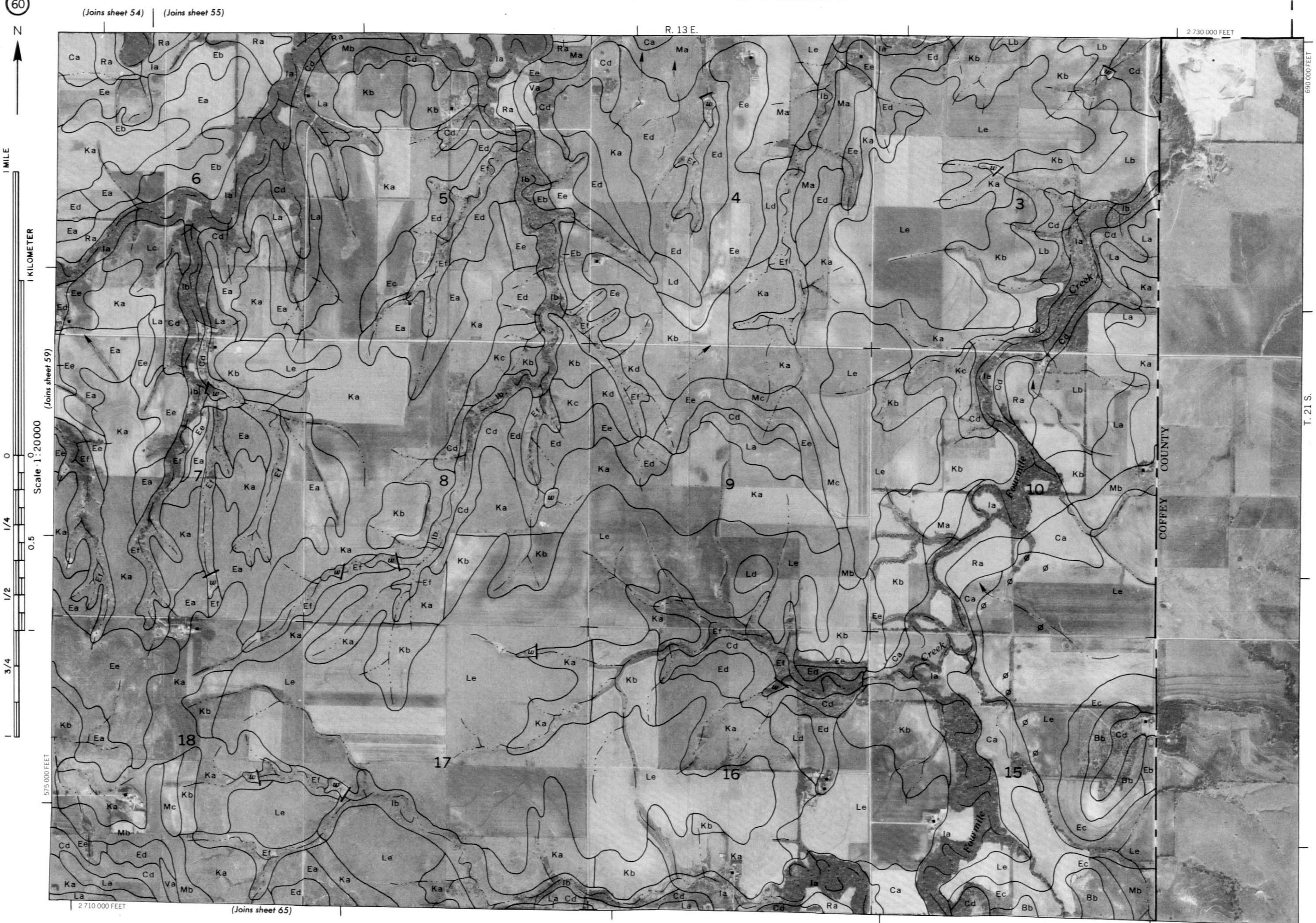
N
2 715 000 FEET
R. 13 E.
(Joins sheet 50)
605 000 FEET
T. 20 S.
(Joins sheet 54)
ST MARYS CEMETERY
HARTFORD CEMETERY
Eagle Creek
Fourmile Creek
COFFEY COUNTY
595 000 FEET
(Joins sheet 60)
2 730 000 FEET
COFFEY CO
19
20
21
22
27
28
29
30
31
32
33
34
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5

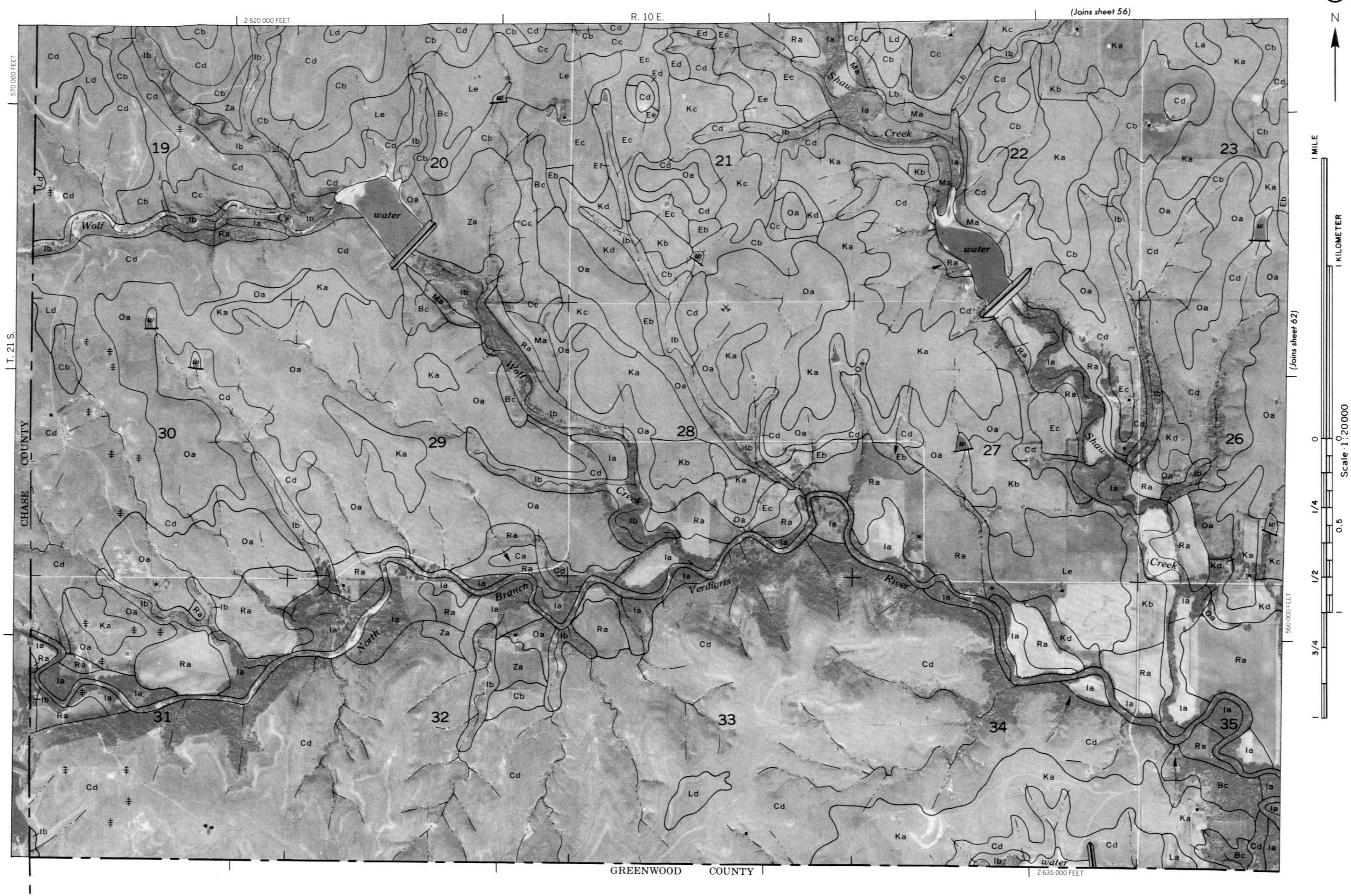

56
N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
0.5
1/2
3/4
1
(Joins sheet 51)
R. 10 E.
2 635 000 FEET
585 000 FEET
T. 21 S.
(Joins sheet 57)
(Joins sheet 61)
2 620 000 FEET
575 000 FEET
CHASE COUNTY
Shaw Creek
Rock Creek
water
2
3
4
5
6
7
8
9
10
11
14
15
16
17
18

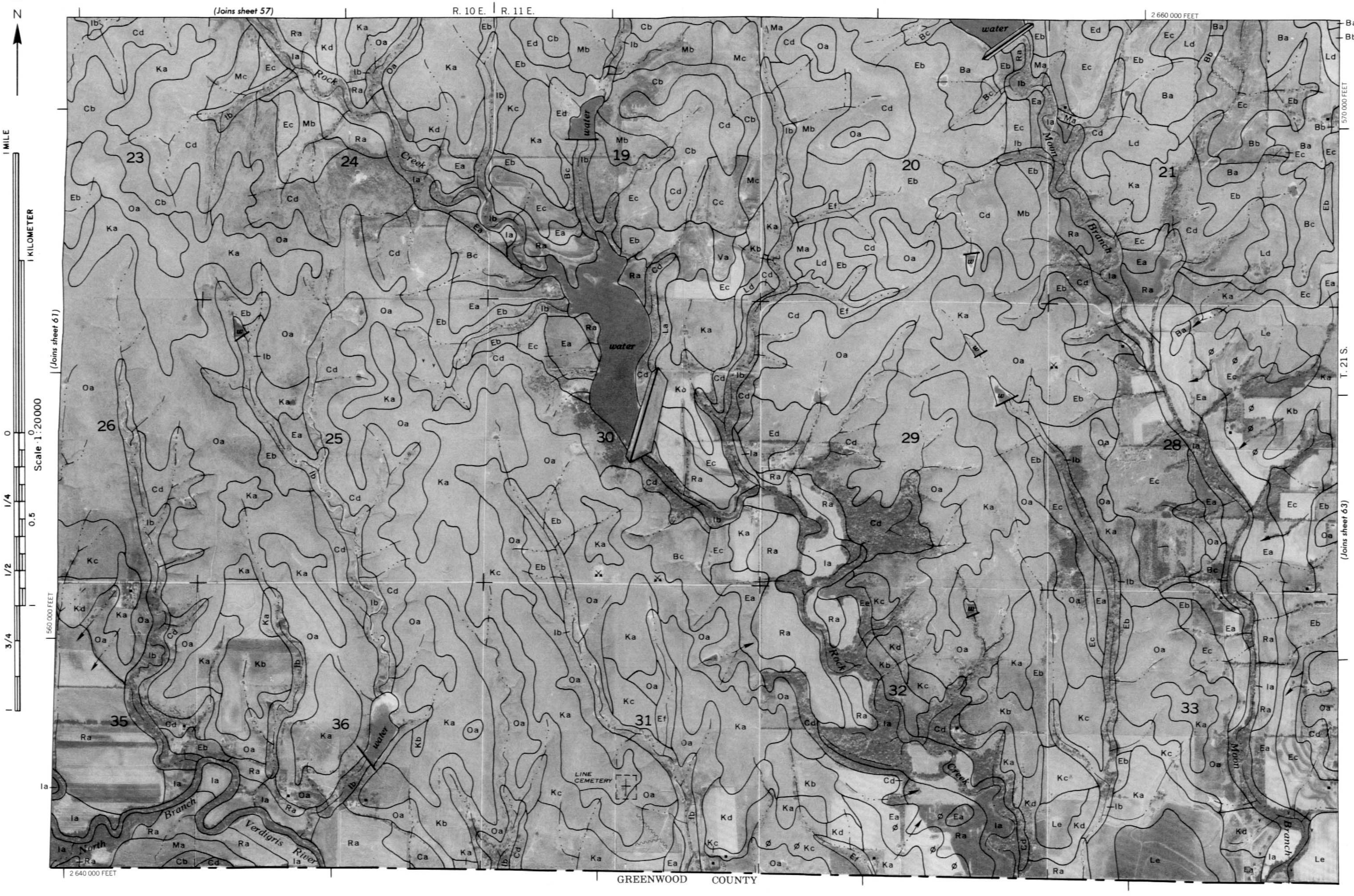

(51) (Joins sheet 52)
2 640 000 FEET
R. 10 E.
R. 11 E.
57
N
585 000 FEET
T. 21 S.
(Joins sheet 56)
(Joins sheet 58)
575 000 FEET
(Joins sheet 62)
2 660 000 FEET
ZION CEMETERY
Rock Creek
Moon Branch
water
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0.5

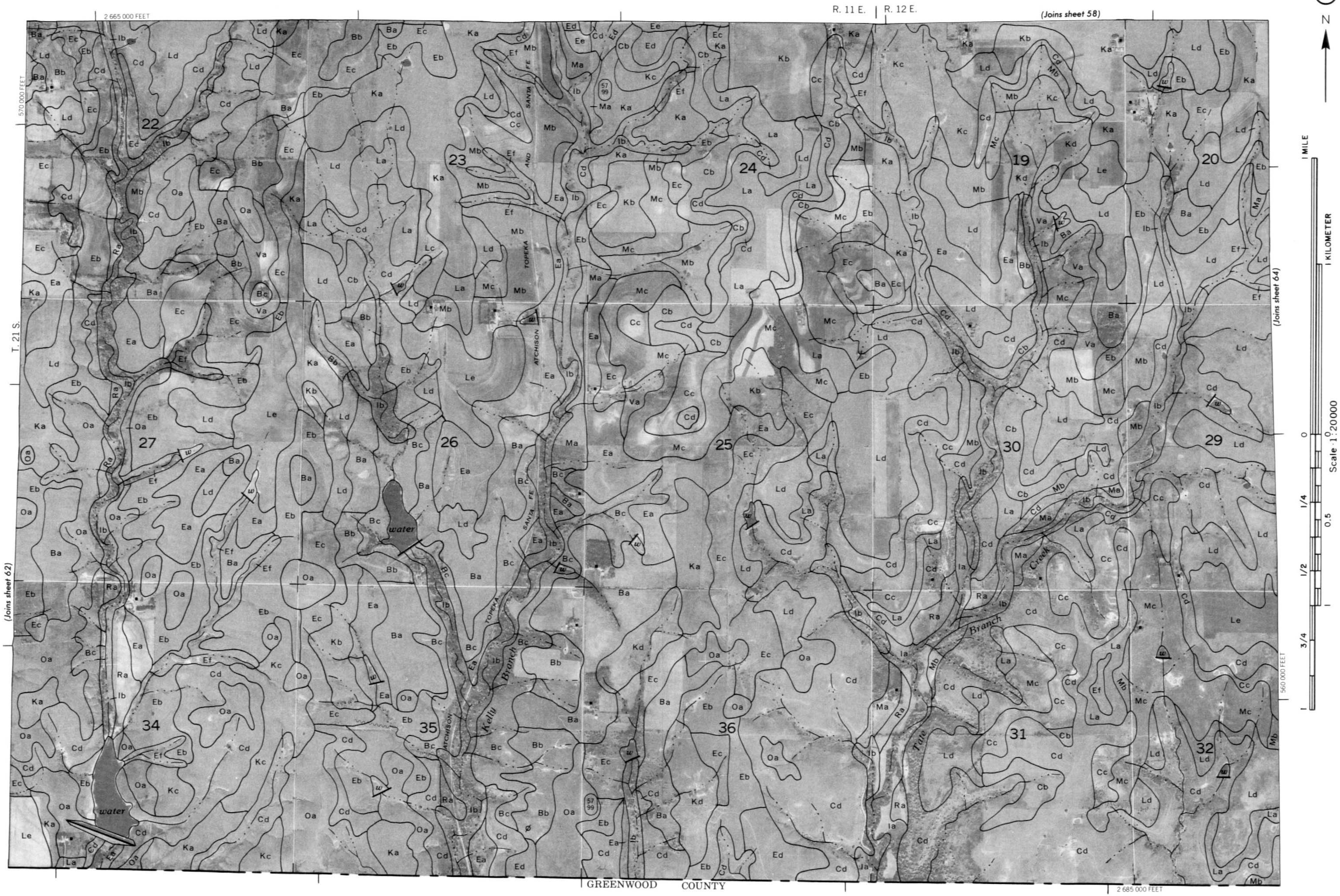

58
N
(Joins 52)
(Joins sheet 53)
R. 11 E.
R. 12 E.
2 685 000 FEET
585 000 FEET
T. 21 S.
(Joins sheet 59)
(Joins sheet 57)
(Joins sheet 63)
2 665 000 FEET
575 000 FEET
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0.5
Olpe
SEWAGE LAGOON
Olpe City Lake
Eagle Creek
South Eagle Cr
Harper Creek
ATCHISON TOPEKA AND SANTA FE
MAYDALE CEMETERY
57
99

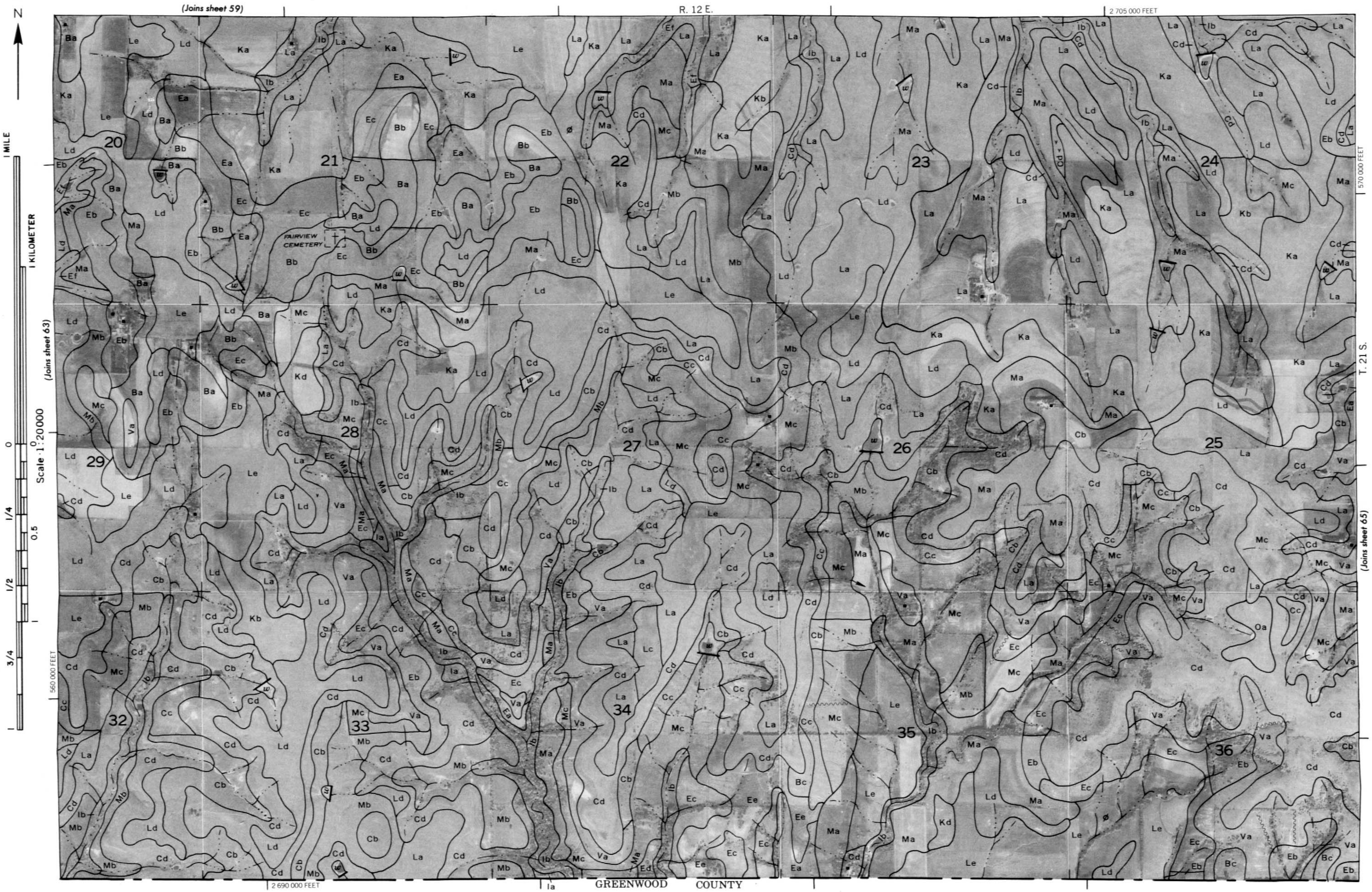

(Joins sheet 53)
(Joins sheet 54)
2 690 000 FEET
R. 12 E.
585 000 FEET
T. 21 S.
(Joins sheet 58)
(Joins sheet 60)
575 000 FEET
(Joins sheet 64)
2 705 000 FEET
South Eagle Creek
South Eagle Cr.
Hoosier Creek
Harper Creek
N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5


N
(Joins sheet 54)
(Joins sheet 55)
(Joins sheet 59)
(Joins sheet 65)
R. 13 E.
T. 21 S.
COFFEY COUNTY
2 730 000 FEET
690 000 FEET
575 000 FEET
2 710 000 FEET
1 MILE
1 KILOMETER
Scale 1:20 000
0
1/4
1/2
3/4
1
0
0.5
1
Fourmile Creek
Fourmile
Creek
3
4
5
6
7
8
9
10
15
16
17
18


61
N
(Joins sheet 56)
R. 10 E.
2 620 000 FEET
570 000 FEET
T. 21 S.
CHASE COUNTY
(Joins sheet 62)
560 000 FEET
GREENWOOD COUNTY
2 635 000 FEET
19
20
21
22
23
26
27
28
29
30
31
32
33
34
35
water
Wolf Cr
Wolf Creek
Shaw Creek
Verdigris River
North Branch
1 MILE
1 KILOMETER
0
1/4
1/2
3/4
0.5
Scale 1:20000


N
(Joins sheet 57)
R. 10 E.
R. 11 E.
2 660 000 FEET
570 000 FEET
(Joins sheet 61)
(Joins sheet 63)
T. 21 S.
560 000 FEET
2 640 000 FEET
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0
0.5
1
Rock Creek
Moon Branch
North Branch
Verdigris River
water
LINE CEMETERY
GREENWOOD COUNTY
19
20
21
23
24
25
26
28
29
30
31
32
33
35
36


N
2 665 000 FEET
R. 11 E.
R. 12 E.
(Joins sheet 58)
570 000 FEET
T. 21 S.
(Joins sheet 62)
(Joins sheet 64)
560 000 FEET
2 685 000 FEET
GREENWOOD COUNTY
ATCHISON TOPEKA AND SANTA FE
Kelly Branch
Tate Branch
Creek
water
1 MILE
1 KILOMETER
Scale 1:20000


N
(Joins sheet 59)
R. 12 E.
2 705 000 FEET
570 000 FEET
T. 21 S.
(Joins sheet 65)
(Joins sheet 63)
560 000 FEET
2 690 000 FEET
GREENWOOD COUNTY
FAIRVIEW CEMETERY
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0
0.5
1
20
21
22
23
24
25
26
27
28
29
32
33
34
35
36


2 710 000 FEET
R. 13 E.
(Joins sheet 60)
570 000 FEET
T. 21 S.
(Joins sheet 64)
COFFEY COUNTY
GREENWOOD COUNTY
2 730 000 FEET
560 000 FEET
Fourmile Creek
19
20
21
22
27
28
29
30
31
32
33
34
N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0
0.5
1